Cruising Equipment

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To: Warren Stokes, President, Heart Interface
From: Rick Proctor, President
Key Words: Intellectual Property

Warren,

The patent party for the Link 2000 was great fun. You know patent law was created to benefit the public. In trade for a 20 year monopoly the inventor must tell everyone how to make his invention. I think we should stress to our people, our customers, and our competitors how important we consider these patents. When you look at, or use, the Link 2000 or the E-Meter it is obvious that we have done original and creative work. Our patents detail how "a person skilled in the art" would make these devices.

Our patent on the Link 2000 protects the high level of integration of inverter/charger, alternator, and battery state-of-charge instrumentation. We believe that **any battery monitoring device that also controls inverter/chargers** and/or alternators **will infringe that patent, or its continuation.**

The E-Meter has had two patents pending and the patent office has recently notified us of issuance on both. One is for the device, including our work on "learning" the charging efficiency, and the way we apply Peukert's equation. The other is on the enclosure, with specific protection for the ratchet ring attachment method. We plan to have a very special party for this very successful product.

It is important the we protect our patent rights so that our company can continue to prosper and grow, and create new products. I am proud that our company has been able to help thousands of people better understand and use the precious energy they collect with renewable energy systems. It is very exciting to participate in the emerging Electric Vehicles industry, you know we have instrumented over 1,000 EVs. This kind of ground breaking work is only possible through the hard work of our engineering team. Their work deserves our respect and the protection of our patents.

Rick Proctor

HOME POWER

THE HANDS-ON JOURNAL OF HOME-MADE POWER

Issue #60 August / September 1997

Features

GoPower

GoPower

Features

Cover: A night shot of the 17.5 kW Jacobs Wind Generator at the 1997 Midwest Renewable Energy Fair, Amherst, WI.

Photo by Richard Perez with thanks to Jeff Hayes for the loan of a tripod and tech support.

Homebrew

Columns

Regulars

Access and Info

Access Data

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Paper and Ink Data

Cover paper is 50% recycled (10% postconsumer and 40% preconsumer) Recovery Gloss from S.D. Warren Paper Company.

Interior paper is recycled (30% postconsumer) Pentair PC-30 Gloss Chlorine Free from Niagara of Wisconsin Paper Corp.

Printed using low VOC vegetable based inks.

Printed by

St. Croix Press, Inc.,
New Richmond, Wisconsin

Legal

Home Power (ISSN 1050-2416) is published bi-monthly for $22.50 per year at PO Box 520, Ashland, OR 97520. International surface subscription for $30 U.S. periodicals postage paid at Ashland, OR, and at additional mailing offices. POSTMASTER send address corrections to Home Power, PO Box 520, Ashland, OR 97520.

Until Victory, Always....

What does Che Guevara have to do with Home Power?

Well, we both have the same motto, "Until Victory, Always!" Che Guevara has always been one of my heroes. He fought a political revolution with a gun, we fight an energy revolution with information. We both have had our victories and defeats. He stuck it through to the end, and we will too.

This is our tenth anniversary issue. That's right, we've been fighting this energy revolution for ten years now. And we will fight it for ten more if need be. Our goals are much the same as Che's—freedom, sustainability, and equality. Our method, instead of deadly force, is of a quieter sort—information and education. But don't let our milder methods fool you, we are as serious about our revolution as Che was about his.

"¡Hasta la victoria, siempre!"

Richard Perez for the Home Power Crew

People

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Shari Prange

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Michael Welch

Donna Wildearth

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Myna Wilson

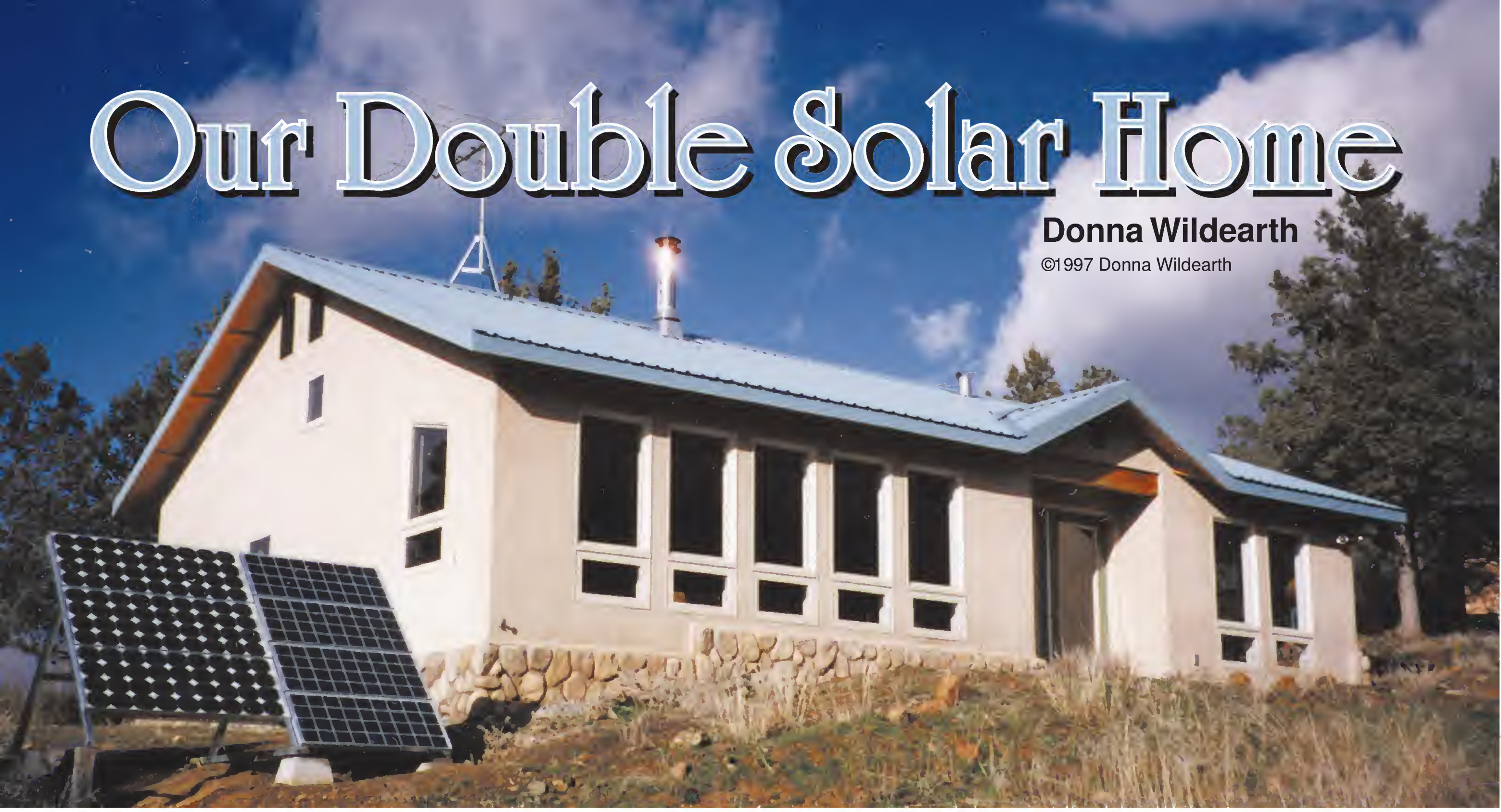
" Think about it..."

"¡Hasta la victoria siempre!"

Che Guevara

Our Double Solar Home

Donna Wildearth



My husband, Chris Reardon, and I live in what I like to think of as a "double solar" house: a house that uses the sun for both heat and power. I want to share some aspects of our house design. But first, some history and a brief overview of passive solar principles.

We live in a mountain valley in far northern California (around 3,000 feet elevation) on land we purchased in 1988. The land was undeveloped except for a well that had been drilled several years earlier. We labored for months putting in a driveway, laying out the water and septic systems, and moving an older mobile home onto the property. We were already philosophically committed to solar energy, so when the local utility company quoted approximately $35,000 to bring in a power line, it was easy for us to decide to go solar. Richard Perez and John Pryor installed our original solar system—two Kyocera photovoltaic panels, four Trojan L-16 batteries, a Trace 2012 inverter, and a Honda 3500 watt generator for backup.

We moved into the trailer in the fall of 1988, exhausted from our efforts but exhilarated by our new surroundings, and dreaming of the house we hoped to build one day. We envisioned a house that was modestly-sized, comfortable, energy efficient, environmentally friendly, and low maintenance. In Chris's words, "a house that takes care of us, not the other way around."

This vision became a reality two years ago. While we loved the idea of building our own house, Chris had a full-time job, and neither of us had any significant construction skills. In the end we opted to hire professionals to build the house. Construction began in April 1995, and we moved into the house in January 1996. After experiencing over seven years of profound thermal discomfort in our trailer, what bliss!

Passive Solar Design

The basic principle of passive solar design is that the house structure itself collects and stores heat by non-mechanical means. (This is in contrast to active solar systems which collect and store heat by means of separate collectors and mechanical equipment such as fans and pumps.) All passive solar structures include a certain amount of south-facing glazing (glass or plastic) that collects heat from sunlight, and thermal mass—material that absorbs and stores the collected heat. Thermal mass typically consists of concrete, brick, adobe, tile, or water.

There are three major approaches to passive solar design, which can be used alone or in combination: direct gain, sunspace/greenhouse, and thermal storage wall (also known as Trombe wall). Our house is a direct gain system, the simplest and most commonly used passive solar strategy in residential applications. Direct gain means that the actual living space is directly heated by sunlight.

To optimize passive solar design, a number of factors must be taken into consideration: the orientation of the house, layout of living spaces, window size and location, size of roof overhangs, and, very important,

provision of adequate thermal mass in proportion to the south facing glazing. A well balanced passive solar design can be tricky to achieve, and, unfortunately, some passive solar houses suffer from overheating, wide temperature swings, glare, etc. However, the wonderful living environment provided by a good passive solar design is definitely worth the effort.

Resources

The main reference I used in the early stages of designing our house was *The Passive Solar Energy Book* by Edward Mazria (Emmaus, PA: Rodale Press, 1979). This book has a wealth of good information, though some of the data may be outdated. Check your local library for this book and others on passive solar design. *Fine Homebuilding* magazine has published a number of articles on the subject that are inspirational and illustrate the wide variety of passive solar house styles.

Above: The kitchen is warm and bright.

Below: Windows in the living room allow the sun to heat the tile covered concrete floor.

Above: Back-up heat is provided by a woodstove.

The one source I consider indispensable for a layperson designing a passive solar house is *Passive Solar Design Strategies: Guidelines for Home Builders*, available from the Passive Solar Industries Council (PSIC). For $50 PSIC will send you a copy of the *Guidelines* customized to your local climate. There are also several software versions of the *Guidelines* available; see Access at the end of this article.

The *Guidelines* contain state-of-the-art information on passive solar design. Most importantly, they contain a set of four worksheets you can use to fine-tune your design. These worksheets cover (1) the overall energy efficiency of the house; (2) the projected contribution of solar glazing to the space heating requirements of the house; (3) whether or not there is adequate thermal mass to maintain comfortable indoor temperature levels; and (4) projected summer cooling performance of the house. Since these worksheets are based on values specific to your climate, the results should hold up in the real world. Another benefit of using the worksheets is that they demonstrate very clearly the relationships between the various design parameters.

I had never designed a house before, much less a passive solar one. Though I had spent many hours researching and refining our house plans, before receiving the *Guidelines* I still had some doubts about my design. I felt it would be prudent to have it double-checked by an architect or solar engineer. When I received the *Guidelines* I worked through all of the worksheets a number of times. This was very helpful in finalizing window sizes, insulation levels, and other details. After this process I felt confident enough about the design that I no longer felt the need to have it checked over by a professional.

House Features

One of the many decisions we had to confront was the basic type of construction. We were intrigued with such alternatives as rammed earth and straw bale construction. However, we planned to take out a building permit for the house, and our county building department is notoriously conservative when it comes to anything other than stick-built houses. In the interest of expediency we chose to utilize standard frame construction. This probably also resulted in cost savings since the materials were readily available, even in our somewhat remote area, and local construction workers were well-versed in the technique.

Our house is oriented due south, though solar glazing oriented to within 15˚ of true south will perform almost as well. The house is partially bermed on the east side to conform to the natural slope of the site. Thermal mass is primarily provided by a 5 inch concrete slab. In addition, we used ceramic tile as flooring throughout the house except in the bedroom and bath, where we used cork floor tile.

Layout

The house is a one-bedroom, one bath design with 1003 sq. ft. of conditioned (living) space and an additional 208 sq. ft. of unconditioned space (storage room, mechanical room, and root cellar). In the future we plan to convert the storage room to a hallway and second bath, and add another room on the northwest corner of the house.

The layout is a very open plan, allowing air and heat to circulate freely. It also provides long lines of sight and a sense of spaciousness to counterbalance the modest dimensions of the house. Notice that high activity areas, the kitchen, dining, and living rooms, are located on the

Floor Plan

Donna and Chris's Solar Home

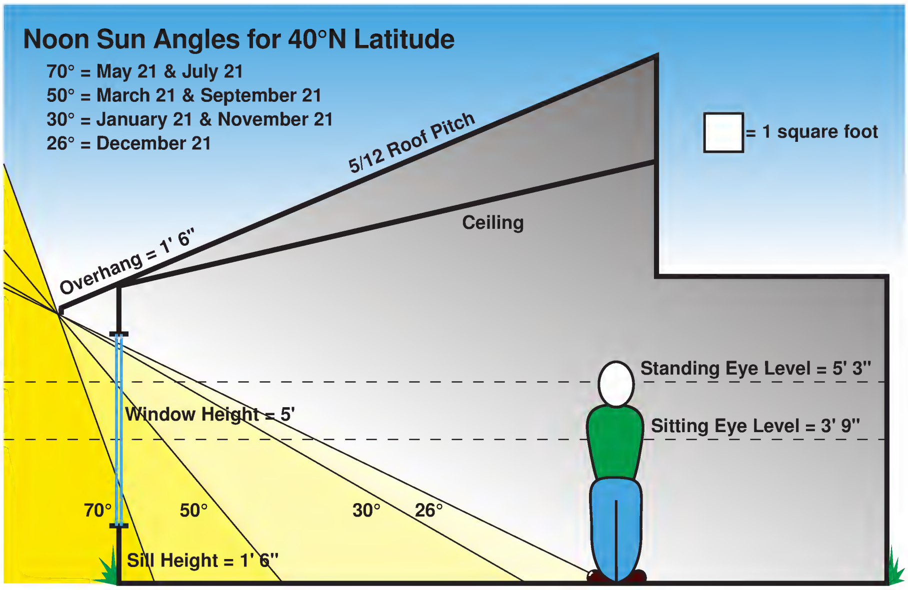
south side of the house to take maximum advantage of the solar warmth and light. Note also that the north side of the house is partially buffered by the unconditioned spaces and the bedroom closet.

Windows

Window size, location, and type are crucial elements in passive solar design. As a rule, windows should be minimized on the north, east and west sides to reduce heat loss in winter and heat gain in summer. Our house has one medium-size north window and two medium-size east windows. The west windows were more problematic. The *Guidelines* recommend that the west window area equal no more than 2% of the total floor area, in our case 20 sq. ft. However, our most dramatic views are to the west. After much agonizing we compromised on 23.75 sq. ft. of west windows.

The windows have vinyl frames and are double-glazed. The north, east, and west windows have low-E coatings (U values = 0.36–0.41). The west windows are slightly tinted to reduce heat gain in summer.

The south face of the house is largely glass. Here I want to mention something that I haven't seen discussed in passive solar literature: structural integrity. When we submitted our plans to the building department, we were informed that engineering would be required on the south wall because of the amount of glass. Engineering calculations showed that the wall was indeed lacking in shear strength. Fortunately, we were able to correct this by reducing the window size slightly and adding 3/8 inch plywood shear panels on both sides of the wall. Nevertheless, it is definitely a factor to consider.



Using night insulation over south-facing windows can appreciably improve energy performance. For example, according to Worksheet 2 from the *Guidelines*, if we used night insulation with a value of R-9 on all south windows, we could reduce the need for backup space heating by approximately 21%. We considered using thermal shutters or roll-up shades but both are bulky and relatively expensive. Furthermore, we like the clean, uncluttered lines of the windows as they are. Since the auxiliary heating needs of the house are already minimal, and privacy is not an issue, we have not installed any form of night insulation.

Another important consideration for south windows is the relationship between the roof overhang and the top and bottom of the window opening. The goal is to allow maximum sunlight into the house in winter, and minimum sunlight in summer. The optimum size of the roof overhang varies with latitude. I made a scale drawing on graph paper of a cross-section of the house showing the south window opening and the noon sun angle at various times of the year. (Information on sun angles at different latitudes is provided in *The Passive Solar Energy Book*.) Since I was also concerned with minimizing glare in the living spaces I included on the drawing two lines indicating eye level when seated and standing. This drawing reassured me that glare would not be a problem and enabled us to size the roof overhang at 18 inches. This worked out beautifully. At the winter solstice, the sun streams 14 feet into the house, while at the summer solstice it only penetrates about 1/2 inch over the windowsills.

Insulation

Good insulation is essential for all houses, including passive solar designs. For both cost and comfort it is better to build a house with high levels of insulation and a moderate amount of south-facing glazing than to build a poorly-insulated house with large amounts of south-facing glazing. We used R-21 fiberglass batts on the exterior walls with a foil vapor barrier installed on the inside face. In the attic we used loose fill cellulose insulation with an R-value of 49. We also used 2 inch thick extruded polystyrene panels (R-10) to insulate the footings and the slab. The sequence of materials underneath the house is: soil, 2 inches of sand, vapor barrier, insulation, 2 inches of sand, slab. The exterior doors are metal with a foam core.

We made a diligent effort to caulk and seal the house, but it is not air-tight. Fresh air enters the house through a 3 inch combustion air intake duct underneath the woodstove and there is a 6 inch vent in the ceiling directly above our propane refrigerator to remove combustion byproducts. Because of the high conservation performance level of the house we are able to enjoy the benefits of fresh air circulation without a significant sacrifice in energy efficiency.

Backup Heat

Almost all passive solar houses need some source of backup heat. It is difficult to design a house with enough thermal mass to carry it through extended periods of overcast, foggy, or stormy weather. Our house's percentage of space heating supplied by the solar glazing is calculated to be 28% (Worksheet 2 of the *Guidelines*), leaving 72% to be supplied by other sources. For flexibility, we chose to utilize two backup sources, a woodstove and a radiant floor heating system.

Radiant floor heaters provide a quiet, even level of heat, in contrast to forced air heating systems with such drawbacks as noisy blowers, leaky ductwork, and dry, dusty air circulating through the house. Our radiant floor system is hot water circulating through tubing embedded in the concrete slab. The water can be heated by a variety of fuels. We use propane, even though it is relatively expensive, since we already had several propane appliances.

Here's where it pays off to have a smaller, well-insulated house. Even though 72% of the space heating requirements must be supplied by backup sources, which may seem high, the actual BTUs involved are quite modest. The contractor who installed our

insulation and radiant floor system ran the house design through a computer program that simulates a building's thermal performance. This program projected that the backup space heating requirements could be provided by either 2/3 of a cord of firewood or $280 of propane a year (calculated at $1.50 a gallon).

Building Materials
Building a non-toxic house is challenging since many typical building materials contain toxic substances of some kind. A totally non-toxic house would be difficult and costly to achieve so we aimed for a house with a low level of toxics. We used redwood sill plates rather than treated lumber. We used fiberglass insulation in the walls but cellulose in the attic, since we are much more likely to enter the attic than to open up the walls.

To minimize formaldehyde exposure we tried to avoid using plywood. We used a cement board product called Harditex for the exterior sheathing (see Access). We also used a special formaldehyde-free medium-density fiberboard called Medite II for shelving in the cupboards and closets and for the battery enclosure.

There are a growing number of non-toxic paints and finishes available. For the interior of the house we used latex paint from Best Paints. This paint has very low odor and a low level of volatile organic compounds (VOC). With shipping included it was only slightly more expensive than conventional paints. We are very satisfied with the appearance and performance of this paint.

Above: The metering niche makes a handy home for a flashlight.

The other interior finishes—wood stains and sealers, floor and grout sealers, and the cork tile adhesive—were ordered from Eco Design Company. Overall, these products worked out very well, though the sealer we used on the unglazed floor tile was somewhat difficult to apply evenly, and we aren't entirely satisfied with its durability. These finishes are definitely more expensive than the ones in your local hardware store but we felt the health benefits outweighed the extra cost.

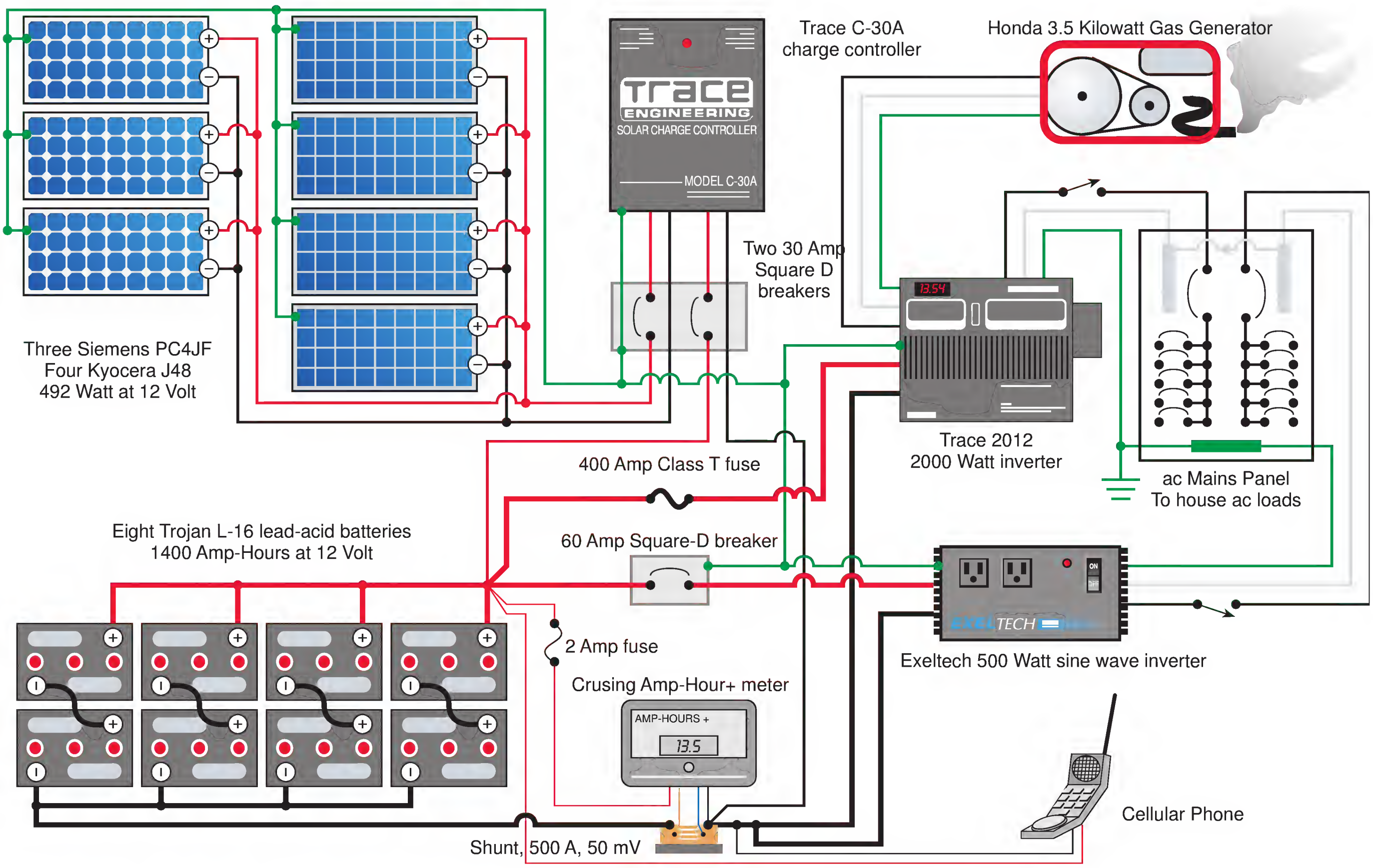
Our house has a metal roof and stucco exterior. Again, we felt the higher cost of these materials was offset by their durability and low maintenance. Their fire resistance is another advantage. We chose several other materials for their low maintenance as well as energy efficiency: tile floors, metal doors, and vinyl window frames.

Solar Electric System
Our solar electric system is fairly standard. We recently doubled the size of our system. It consists of 7 solar modules (4 Kyocera 48 Watt panels and 3 Siemens 75 Watt panels), a Trace C30A+ charge controller, 8 Trojan L-16 batteries, a Trace 2012 inverter, an Exeltech 500 watt inverter, and a Cruising Equipment Co. amp-hour meter. The equipment was installed to code and passed the county building inspection. The house is wired for conventional 120 vac. Our cellular telephone is the only appliance that runs directly off the batteries.

The solar panels are ground-mounted at the southwest corner of the house. The charge controller, batteries, and inverters are in the mechanical room at the back of the house. The batteries are in an air-tight enclosure vented to the outside. A small cupboard inside next to the back door contains the amp-hour meter and a remote on/off switch for the Trace inverter. This allows us to conveniently monitor the system from inside the house.

With the Trace inverter there was a noticeable buzz on audio equipment. When we moved into our house we added the Exeltech sine wave inverter. It is wired to a separate circuit serving the stereo system and my husband's home music studio, and has eliminated the problem.

Our major system loads include lights, toaster, vacuum, music studio, audio system, TV/VCR, range exhaust



hood, and blender. Seasonal loads include the circulating pumps for the radiant floor heating system and ceiling and portable fans in summer. We use compact fluorescent bulbs throughout the house (mostly the Philips SLS series), except in fixtures that we typically use for brief periods of time. The surge load of our washing machine is too much for the Trace inverter to handle, so we run the generator whenever we launder. Our water heater, refrigerator, and cook stove are propane fueled.

We've only lived with the expanded power system for a month, so it's a little difficult to evaluate. However, even with the current early spring weather of mixed sunshine and clouds, the battery voltage has held up very well. We haven't yet had to run the generator to charge up the batteries. It looks like the system will be a good match for our energy usage.

It's also hard to calculate the overall cost of our system since we built it in stages over nine years. The closest figure I can come up with is roughly $10,000. This includes the cost of our generator but not the cost of the original 4 batteries, which we retired when we expanded the system.

Our water pump is located over 800 feet from the house and has its own power system. It's a Solarjack submersible that runs directly off 2 Kyocera 48 Watt modules connected to a Solarjack pump controller set for 24 VDC. Water is pumped to an underground concrete storage tank and gravity flows from there to the house.

House Performance

The house has exceeded our expectations in terms of energy efficiency and comfort. Due to the thermal mass and high levels of insulation, house temperatures are quite stable. Last fall, in spells of cold but sunny weather, the house warmed up to about 76˚ during the day. In the mornings, without any backup heat, the house temperature was around 66˚, while the outside temperature was in the mid to low 20's.

This past winter was not a good one for passive solar, as we had very few sunny days. We didn't activate the radiant floor heating system until after the holidays, so the woodstove was our only source of backup heat in the fall and early winter. Even so, we didn't start using the woodstove until weeks after we noticed smoke coming from our neighbors' chimneys. We estimate that we have burned just a little more than half a cord of firewood to date (mid March).

House performance in hot weather is not quite as optimal, though we are relying on the fact that our area

is cold much more of the year than it is hot. Last summer was unusually hot, with many days over 100˚. Our solar electric system is not large enough to support the energy draw of an air conditioner and we don't have an evaporative cooler. Nevertheless, the house temperature didn't get above 86˚, even in prolonged hot spells.

We opened all the windows at night, to exhaust hot air and expose the thermal mass to cooler nighttime temperatures. We used removable awnings on the south windows to shield the house from the lower sun angles of late summer and early fall. We also used outdoor shades on the west windows.

The house is wired for two ceiling fans in the main living area, which we have not yet installed. We are hoping that, with the ceiling fans in place and more normal summer temperatures, the house will be cooler and even more comfortable.

Predictably, the house cost more than our original estimate. It totaled about $75 per sq. ft. However, I think the house could be built for significantly less money without compromising its energy efficiency. This could be accomplished by using your own labor, eliminating the radiant floor heating system, and substituting less expensive materials in such areas as counter tops, cabinets, roof, and exterior siding.

We are very happy with the house, and feel it has met our original goals admirably. Someday soon we hope to incorporate a solar hot water system. We sized the mechanical room to accommodate a storage tank for solar preheated water. In the meantime, we delight in using the sun's energy to pump our water and power and heat our house. We watch the dance of the sunlight—advancing further and further into the house in fall, and retreating in spring. And I cherish the remark of a friend who characterized our house as "a temple of the sun."

Access

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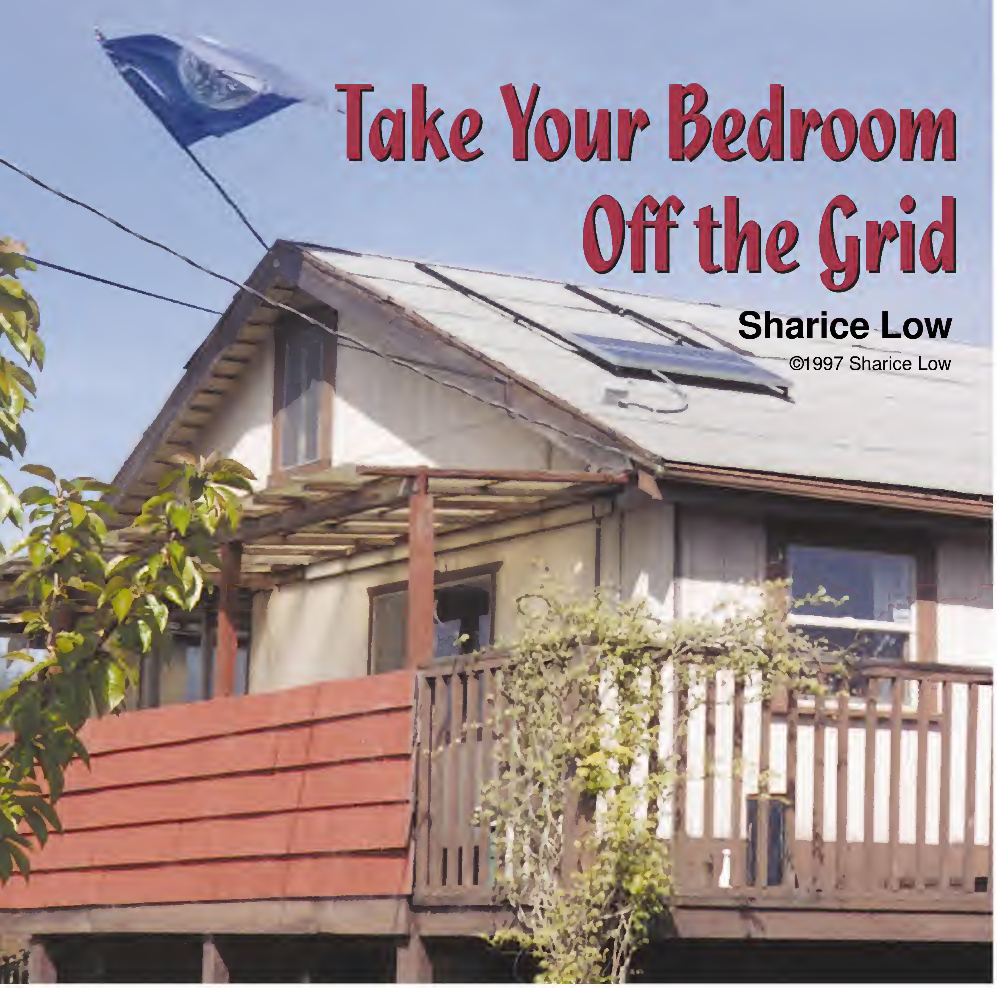


Take Your Bedroom Off the Grid

Sharice Low

Left: Earth Church flies the flag of its namesake.

In recent years there has been a growing interest in renewable energy. The problem is that many people cannot afford to implement a complete renewable energy system all at once. As interest grows and renewable energy equipment prices fall, people will not be ready to take advantage unless the industry and non-profits undertake serious public education.

Redwood Alliance, an environmental organization that deals with energy issues, has addressed the problem with a workshop teaching the public to implement a renewable energy system a little at a time: "Take Your Bedroom Off the Grid." The idea is that many people can afford $600 to $2500 to take a portion of their house off the grid. It may be with one module and one battery to run 12 Volt DC equipment, or a more elaborate system powering an isolated ac circuit in their house.

Start Small and Expand

A system like this is implemented with expansion in mind, starting out small with what you can afford and expanding as time goes on. At a relatively low cost you could invest in one module, a small battery, safety equipment, and hardware, to run DC lighting and stereo equipment. Or you could use a small system with an inverter and a plug strip to power some of the appliances in your home. With a little electrical knowledge you could even separate out and power one existing household circuit using solar electricity. At any time more modules and/or batteries can be added. Whenever possible, size wiring, controls, and safety equipment to handle some growth, as it can be difficult and expensive to change later on. So next year, when you get your income tax returns, for example, you can add two more panels, and the next year two more. Then a couple years down the road, you can take another circuit of your house off the grid and gradually expand, until one day your whole home is powered entirely by solar electricity!

Education

With the "Take Your Bedroom Off the Grid" idea people will be educated so that they can make the right decisions, choose the right equipment, choose the right installers, or do it themselves. Even more basic, most people do not at all recognize the possibility that they can make or use renewable electricity. So, Redwood Alliance undertook the project of bringing an educational workshop to its community, Arcata California. We wanted the workshop to include

Below: Instructor Johnny Weiss and workshop organizer Sharice Low.

everything from the basics of what renewable energy is, to system sizing, efficiency within the home, system design, and an actual hands-on installation. We also wanted the workshop to be affordable and accessible to as many people as possible. We expected a wide range of attendees, but knew that most of them would be novices in the world of home-made electricity.

Redwood Alliance would like to share our workshop with any interested communities. If you would like to introduce the "Take Your Bedroom Off the Grid" concept in your own area, please contact us.

Do Folks Want It?

The first task to putting on a workshop of this sort, which as far as we know had never been done before, was to determine the demand. We composed a returnable questionnaire asking about the level of interest in such a workshop, the amount of money community members would be willing to pay for the workshop, the timing and length that would be preferable, and if they would be interested in allowing us to use their home for the hands-on installation portion of the seminar. We did a sample mailing of 500 questionnaires, of which we received 30 back. We felt that this response was good enough to send out the additional 1500 questionnaires. Our total number of responses was 135, and of those responses 23 people participated in the seminar. We used the information from the questionnaires to get a feel for how many people would attend the workshop. Based on this we were able to make projections for the attendance price of the workshop. We also decided, based on the responses, that a weekend long workshop would be the most appropriate, as most people in our community could not participate during the week.

Above: John Gary of Earth Church looks over two PV panels on a rack that can hold six: room for expansion.

Our next task was to decide if we were able to afford having the workshop professionally taught. We hired Johnny Weiss of Solar Energy International to handle the workshop lecturing. Johnny's knowledge and experience in putting on educational workshops is vast, and he had quite a task condensing weeks of information into one weekend worth of lectures. He did a tremendous job and helped to make our seminar a success.

Below: Johnny Weiss lays out PV theory for workshop attendees in Arcata, California.

We wanted our community members to be able to afford a reasonably priced informative workshop. In order to do this and still have the lecturing and preliminary installation work professionally done meant that we had to find sponsorship. We received a cash sponsorship and help with advertising from our local North Coast Co-op, who is always doing a lot for our community. Alternative Energy Engineering paid for a significant portion of our mailing costs, provided assistance (thanks to Jay Peltz) and equipment

Above: L–R Janet McVicar, Lori Rose, Raul Lozano, and Elias Elias get their hands on the technology.

(modules, wiring, batteries, and multi-meters) for the lab stations on the second day of our seminar. AEE also agreed to give all workshop participants a discount on system equipment. Bob-O Schultze and Joe Schwartz of Electron Connection devoted numerous hours to our workshop. They did a site survey of the five potential homes for the hands-on installation portion of our workshop, and handled the preliminary work for the installation itself (running conduit, installing breaker boxes, and installing the brackets for the PV roof mount). It was important having these experienced electricians on site during the installation to head off any problems the participants had. Truly, without the help of each of our sponsors, this seminar would never have been possible.

Workshop Schedule

The workshop started off with an introductory slide show on Friday night that was open to the public and targeted for those who wanted only a general overview of what is going on in the renewable energy industry. Johnny had an interesting slide show on the whys and hows of the renewable energy.

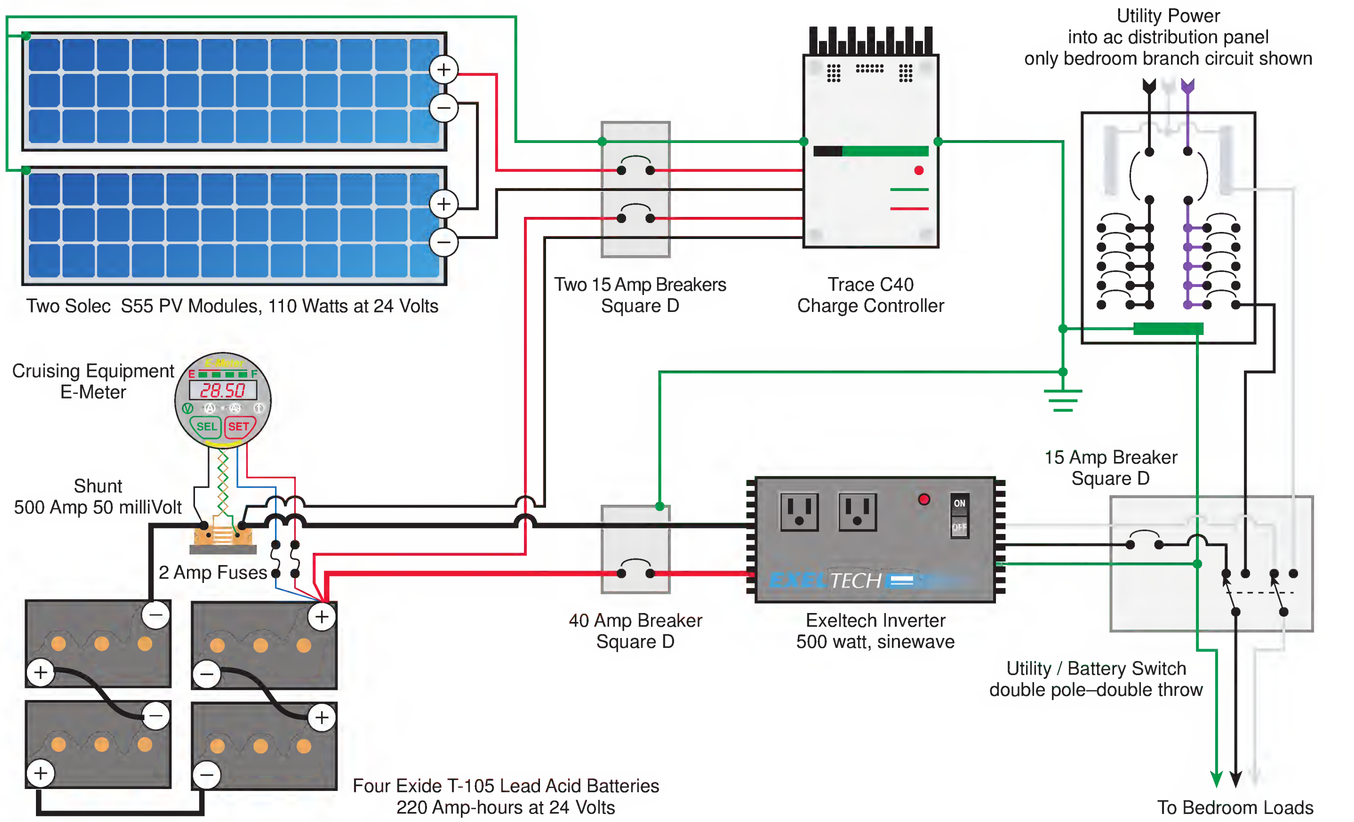
The rest of the seminar was three days of in-depth explanation and implementation for the participants who paid. Depending on the participant's schedule, finances, and amount of desired knowledge, they could participate in one, two, or all three days of the workshop.

Saturday's workshop began with the needs and consideration of designing a solar electric system. It was an opportunity to get a basic understanding for those who were considering having someone professionally install their solar electric system, or for those who just wanted to know more about it. Some of the information presented included PV electricity concepts, solar site analysis, system sizing, and electrical loads. The cost of attending Saturday only was $25.

Sunday's workshop was more in-depth and built upon Saturday's. It was for those who want to learn still more or want to do their own installation. The participants learned details about the hardware of solar electric systems and worked at hands-on lab stations. The cost of attending both Saturday and Sunday was $45.

Monday's session was the final option, with on-site lab work and the actual hands-on installation of a real system. This was the best part! We charged $60 to attend all three days.

Below: Jay Peltz helps set up Sunday's PV wiring lab.



We started Monday's installation with a lab, where we wired one module to a water pump in a bucket and demonstrated the effects of shading the module. We then did exercises about how to wire the batteries and modules which we were about to install, working with series and parallel wiring. The rest of the day we worked in small groups mounting the panels, wiring the batteries, and hooking up the inverter and charge controller. All groups were assisted by a professional, and the participants were free to move among the groups as the day progressed. That way everyone had a hand in the whole procedure.

Earth Church

The system that we installed was several steps up from the most basic system you can implement. The site for the system was the Earth Church, a demonstration home for sustainable living. Of the five sites looked at for our hands-on portion of the workshop, the Earth Church had the funds and the most appropriate situation for the installation of a demonstration system. The Earth Church has a two module, 24 Volt system that powers an isolated ac circuit suppling roughly half of their home.

We mounted the array on the roof, with an adjustable tilting rack big enough to hold six modules. The angle is manually adjusted twice a year, at spring and fall equinox.

From the array, the power ran though #2 wire in conduit into the basement, where we mounted the charge controller, inverter, and placed the batteries. We used four 220 Amp-hour batteries, wired in series to give us 24 Volts. The batteries were stored in Rubbermaid® containers to contain spills.

Left: Trace C-40 charge controller and bracketing 15 Amp breakers.

Right: Exeltech 500 watt inverter, breakers, and utility/battery switch.

Above: Author Sharice Low (far right), Johnny Weis, and workshop participants.

Take Your Bedroom Off the Grid Workshop Installation

#	Component	Cost	%
2	Solec S55 55 Watt Modules	$700	27%
1	Exeltech 500 watt Sinewave Inverter	$625	24%
4	Exide T-105 220 Amp-hour Batteries	$340	13%
1	E-meter	$195	8%
1	Trace C40 Charge Controller	$185	7%
1	Rack Roof Mount (for 6 Modules)	$178	7%
	Misc. Cable, Conduit, and Hardware	$125	5%
3	Circuit Breakers	$95	4%
2	Square D Boxes	$85	3%
1	Toggle Switch	$30	1%
2	18 gal Rubbermaid Containers	$22	1%
	Total	$2,580	

Grid-Solar Switch

A neat thing about the system that the workshop participants installed at Earth Church is that there is always power. When the batteries are full and the sun is shining, there is solar electric power. Then, when the batteries are low from days of raining, as it is prone to do here on the North Coast, John Gary, of Earth Church can flip the transfer switch and go back on the grid until his batteries are recharged from the sun. This is a good way for first-time users to learn a system's capacity and how important the management of electrical loads can be. The only problem with this system is that there is no battery charger to keep the batteries topped off, and the array is probably not large enough to equalize the batteries. This could lessen the life of the batteries over a long period of time.

To increase the ease with which the system owners can understand their system and see what is going on inside, an E-Meter was installed in their living room. An E-Meter is used to measure battery Ampere-hours, Voltage, Current, and the time remaining until the battery is fully discharged. These things are critical to understanding the state of charge of the batteries. This also tells the Earth Church when to switch back over to the grid, in order to give the batteries a chance to recharge.

Earth Church plans to run their batteries only to 70% before recharging again. At 220 Amp-hours, this gives them approximately 70 Amp-hours per cycle, given that the batteries are charged completely each time. The Earth Church uses this power mostly for lighting. At the present time they do not have compact fluorescent lighting, but are hoping to be able to purchase new lights soon. The use of compact fluorescent will greatly increase the amount of power that is left over for other things, or increase the length of time between switching back to the grid.

Expansion Plans

Redwood Alliance is going to be lending the Earth Church four more 45 Watt modules to complete their array of six panels, still running at 24 Volts. This will increase the power going into their system, which has already been prewired to accommodate a full array. In the future the Earth Church will be expanding their system. They will next save up their money ($2500) for

Below: Exide T-105s in spill-proof tubs.

a higher powered inverter which will allow them to eventually take their whole house off the grid or even sell their excess power to the utility. Their final step will be to add more batteries to their system.

Success

We felt the workshop was a tremendous success. Participants were able to attend a workshop and gain valuable experience, and take home not only lessons learned, but also an in depth 100 page information packet on PV basics, system design, system efficiency, mounting, and much, much more. (We have extra packets for sale at $12, contact Redwood Alliance.) As for us at Redwood Alliance, the workshop took a considerable amount of time and work to put on, but proved to be a lot of fun and well worth the experience. Maybe it will become an annual event locally.

We had hoped to break even on the workshop expenditures. As of date we are about $350 in the hole, due to the forgotten cost and the over printing of the information packets for the seminar. All things considered, we made it happen and we fared well. We would like to share our experience with others. If you are interested in doing this workshop in your community, please contact us.

Access

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Web: www.northcoastco-op.com

Sponsor, Electron Connection, PO Box 203, Hornbrook, CA 96044 • 916-475-3402
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Sponsor, Alternative Energy Engineering, PO Box 339, Redway, CA 95560 • 800-777-6609
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Instructor: Johnny Weiss, Solar Energy International, PO Box 715, Carbondale, CO 81623 • 970-963-8855
E-mail: sei@solarenergy.org
Web: http://solstice.crest.org/renewables/sei

System Owner: Earth Church, 2590 Eye St., Arcata, CA 95521 • 707-822-5769

MREF '97

The People Made It Happen

The 17.5 kilowatt wind genny marks the fair grounds from miles around

Bob, Tehri Parker, & Susan Stein, Co-Executive Directors

Mickey Wurl-Koth of Solar Spectrum explains solar site analysis

Tour of RE Homes

Bob Ramlow details the basics of PV systems

Chris Mollelo of Southwest Wind Power shows off the Air

82 Exhibitors

Smitty of AAA Solar

More than open mike: Patty Larken played on Saturday eve.

Michael Hackleman on Electric Vehicles

Solar Sprint

Bike Races

Richard Perez gets a pre-flight check on Bob Turner's hybrid trike

Waiting for a hole in the clouds

Tom Burns displays extremes in Sun Oven technology

57 Sponsors

Chris LaForge
of Great Norhtern Solar
in the power room of the model home

John Hippensteel,
new owner of
Lake Michigan Wind & Sun

Richard Perez
talks batteries

117 Different Workshops

Humor helps: The Rad Waste guys say, “Yes, in my back yard!”

Donna Fischer of Amazon Solar

Elliott Bayly
of World Power
Technologies

Steve Kalland of the Solar
Energy Industries Assoc.

Kim Bowker talks shop

Electric Vehicles

One of the many EVs

Mick Sagrillo teaches wind power theory

Back Home magazine picks up where *Home Power* leaves off (& vice versa)

750 Members

Windy Dankoff with Sunrise deep well pump

Ice Cream

Kid-powered ice cream

Goofin' off: fun for all ages

Michael Welch explains ram pumps

Greg Lynch taught workshops on building and using solar cookers

Mark Klein of Gimme Shelter on superinsulation

225 Volunteers

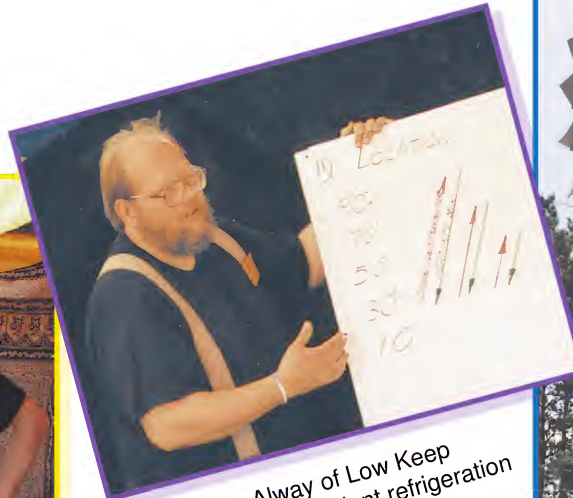
BP's new all-in-one PV/Engine system

Laurie Stone & Oliver Strube-Callihan of Solar Energy International

"Powerhouse" Paul Cunningham, Kelly Larson of AEE, Michael Welch of *Home Power*

Brätwurst

The new Siemens 100 Watt module
& friend from Sun Wise



Dan Alway of Low Keep
"chills out" on efficient refrigeration

The other wind power:
Bryce Black's
LoTec Windmill Service
sells & services water pumpers

10 Thousand Visitors

Chuck Marken of AAA Solar
teaches solar heat & hot water

Jim Kerbel of
Photovoltaic
Systems Co.

Massages

Some of the technology was in
the parking lot: an S-rotor homebrew

Playing the drum
at the primative
skills booth

Sweat education on the Energy Cycle

Solar Sprint

Track-Side Report

Don Kulha

Outrageous Magic in the pits

Each year Junior Solar Sprint (JSS) races host over 50,000 hopeful 6th thru 8th graders. Participants stand to gain a new appreciation for renewable energy and science while using their creativity in a fun project. JSS is an educational program sponsored by the Dept. of Energy (DOE) and managed by the National Renewable Energy Lab (NREL) who provide technical aid to organizations hosting events. Participants or sponsors purchase kits from which the students will construct their solar racers guided by a simple set of rules, and using the supplied panel and motor. The kids were having such a great time with this that some of us "adults" decided to take to the track and get in on the fun.

The Midwest Renewable Energy Fair (MREF) hosted a "Senior Solar Sprint" race this year bringing out seven solar racers in search of friendly competition and a test of their ingenuity. The entries displayed a variety of interesting concepts such as a pasta-box monocoque chassis, four-wheel drive, and one with a fuzzy Holstein-pattern cover for easy repositioning of its Velcro® equipped PV panel. The eventual winner was my high-tech entry named *outrageous.magic*. "Senior" and JSS racers take note; I'll share our speed secrets, but there will be a test later—on the track.

The winning Solar Sprint car will be the one best achieving the goals of minimum weight, low wind and rolling resistance, and maximum energy captured and transferred to the drive wheel(s). Reliability and sturdiness are equally important; you can't win if you don't finish. My entry used a lightweight aluminum drive "pod" supporting the motor, front axle bearings, line-guide and a pivot for the PV panel. The carbon fiber drive axle rolled in ball bearings and mounted a nylon 64-pitch spur gear (88T) on a custom hub driven by a metal pinion gear (15T) used in slot cars. The rear chassis was made from carbon fiber rod, chosen for its stiffness and resiliency. It mounted the rear wheels, rear line-guide and angle-adjustable rear panel mount. Front wheels are modified foam model aircraft items and the rears plastic disks with custom teflon hubs. The PV panel has attached concentrating reflectors of 2 mil

They're Off!

aluminized mylar epoxied to 0.039 inch diameter music wire and could be moved and locked in place at the optimum solar collection angle. In early test runs this racer indicated a need for front and rear line-guides by fish-tailing and flipping on its back at mid-track. In finished form, our car is 16 inches long, weighs less than 8 ounces and runs the regulation 65 foot course in just under 6.5 seconds. It takes a lot of work to build a winning entry and friends Tim Porritt, Rob Thomas and Joe Peterson were a great help during the month long "thrash" to get our racer ready for MREF.

Don Kulha does a winners cheer

I'm looking forward to some stiff competition at the second annual Senior Solar Sprint at MREF next year. To aid Senior and JSS racers, Home Power will be running a series of articles on Solar Sprint racing and technology to help you have fun, field a competitive entry, and learn a bit in the process. See you at the track!

P.S.—"Senior" racers note: Better come to MREF "built for speed"; *Magic Too* will be faster....

Access

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NREL Education Office, Solar Sprint Host and educator technical aid, 1-800-NEW-ENGY
Builder and Educator info at URL: www.nrel.gov/business/education/SprintWeb

Solar Sprint kits available from: Pitsco, 1-800-835-0686

John Root, Richard Komp, & Carol Welling say "Solar Sprint ain't just for kids."

LED Lighting Shootout

Richard Perez

Here is a lighting test—which lighting technology can produce the most light for the least power? The hands down winner is the light emitting diode (LED) which makes three times more light per watt than a compact fluorescent and 30 times more than a standard incandescent.

What is an LED?

Just as its name, light emitting diode, implies, the LED is an electronic diode not much different from any other semiconductor diode. What makes an LED special is that its semiconductor junction is designed to convert current flow into visible light. LEDs have been around as discrete colored lights for quite awhile. Just about everyone is familiar with the LED as indicators on electronics. They came in various colors such as red, green, and yellow. Recent advances have made blue and now, finally, white light available from LEDs. The intensity of the LEDs light output is also increasing rapidly. Modern LEDs can have over a hundred times more light output than those available ten years ago. It is now possible to assemble lighting from a collection of LEDs.

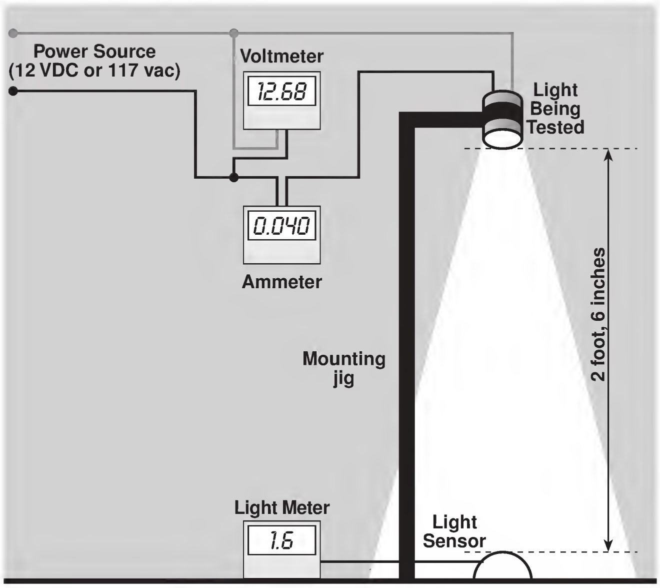
The LED is inherently a low voltage DC device. LED junctions operate at between 1.8 VDC to just over 3.1 VDC. This junction voltage drop is built into the physics of the diode. While different colored LEDs have different junction voltage drops, they all fall into the 1.8 to 3.1 VDC range. When it comes to using LEDs efficiently, the data here shows that they are best employed using low voltage DC as a power source.

The LED has several advantages in addition to high efficiency electricity to light conversion. The LED is the longest lived light making device ever invented. LEDs now commonly last 500,000 hours before failure. With use every night, all night, this means that an LED will last for over 100 years! Physically the LED is very rugged and can withstand moisture, vibration, and shocks which would easily destroy a compact fluorescent or incandescent lamp. The LED lamps also produce no radio frequency interference (RFI), while the same cannot be said for many compact fluorescents.

I've been using LED lights around our home for several years and decided it was time measure their performance against other efficient lighting technologies.

The Test Jig

I set up the simple light testing jig shown in the illustration here. I designed this particular test jig to simulate a desk lighting situation or reading in a chair situation. I used a Greenlee Textron model 93-1065F Digital Illuminometer to measure the light output of the various lamps tested. This light meter is designed to measure light levels from lighting fixtures for the purpose of verifying that lighting specifications or



standards have been met. The Greenlee reads out in foot-candles. The distance from the lamp to the light sensor on the Greenlee was 2.5 feet (0.77 meters). I made the electrical measurements (voltage and amperage) using two Fluke 87 digital multimeters.

Please note that this test jig simulates “task” or focused lighting. This jig was not designed to simulate wide area lighting. Since the Greenlee’s light sensor is in a specific location, light not falling on the sensor is not measured. This jig measures light that is focused on a specific area, such as a desk or a reading chair. All LEDs contain a lens which focuses their light in a single direction, much like a reflector used on conventional lighting. This focused beam output makes the LEDs suited to task lighting.

The Test Results

In all I tested nine different lights. The majority were LEDs, but I also tested two compact fluorescents and one standard incandescent lamp. The data on the table speaks for itself. The bold figures at the right edge of the table show the bottom line—how many foot-candles of light do you get per watt of power. Here the LEDs show a clear superiority to other lighting technologies. In some cases, this is a comparison of apples and oranges because the power consumption and gross light output varies so widely between the various technologies. While the conventional lamps tested consumed around 20 watts of power, the LEDs consumed between 0.5 watts and 6.9 watts. Light output varied from 1.6 foot-candles to 5.6 foot-candles on the LEDs, while the conventional lights put out between 1.4 and 23.9 foot-candles. So how many foot-candles do we need to be able to read? Well that depends on the person and the situation. In my particular case I can easily read with around 1 foot-candle of light. In fact, I have been using Light #7 to read by every night for the last five months. I find it far brighter than the 12 VDC incandescent it replaced (and 15% of the power consumption even though it runs on 117 vac).

The Players

Here is a brief description of each of the lights tested. I realize that there are many conventional lighting technologies not represented in this test. I included the three conventional lights so that we would have some common basis for comparison. This is primarily a test of LED lights. The data on the lighting table is sorted by the right most column—foot-candles per watt. Hence the most efficient light falls at the top of the table and the least efficient on the bottom.

Light 1

This light is made from nine white LEDs and is powered by 12 VDC. Since all LEDs are low voltage DC devices, this 12 VDC model is far more efficient than Lamp #7 which has about the same light output, but is powered by 117 vac. This light has a standard screw in lamp base and can be used with conventional medium screw base light sockets. Delta Lights makes this lamp and the retail cost is $75.

How LEDs compare with other energy efficient lighting technologies

Light #	*Light Description*	*Power Type*	*Measured Volts*	*Measured Amps*	*Measured Watts*	*Light in Ft.-Candles*	*Ft.-Candles per Watt*
1	Delta Lights LH2 9 white LEDs	12 VDC	12.68	0.040	0.507	1.6	**3.155**
2	Jade Mtn 9 red, 3 blue LEDs	12 VDC	12.65	0.069	0.873	2.6	**2.979**
3	Delta Lights LH2-LVD-P 9 white LEDs	12 VDC	12.72	0.067	0.852	1.7	**1.995**
4	Osram EL11R CF w/ reflector	117 vac	118.70	0.169	20.060	23.9	**1.191**
5	Delta Lights LAC10WL 17 white LEDs	117 vac	118.40	0.029	3.434	2.9	**0.845**
6	Delta Lights LAC7WL 34 white LEDs	117 vac	118.30	0.058	6.861	5.6	**0.816**
7	Delta Lights LH4 10 white LEDs	117 vac	118.30	0.033	3.904	1.6	**0.410**
8	Osram EL15 compact fluorescent	117 vac	118.30	0.242	28.629	11.2	**0.391**
9	GE 25 watt incandescent lamp	117 vac	118.20	0.196	23.167	2.4	**0.104**

Light 2
This 12 VDC lamp uses nine red LEDs and three blue LEDs to produce a fairly color correct white light. While not as color correct as the white LEDs, this combination is fine for reading and, as the figures show, brighter than the white LED models. This lamp is made by Jade Mountain and costs $49 retail. See HP # 57, page 74 for a Things that Work! review of this light.

Light 3
The lamp is exactly the same as Light 1, but contains an automatic photosensor that shuts it off during the day and a low voltage disconnect to prevent the lamp from overdischarging a small battery. Note that the electronic controls significantly increase the lamp's power consumption while not providing any more light. This Delta Light has a retail cost of $93.

Light 4
This is a regular 117 vac compact fluorescent made by Osram. This model uses a reflector to focus its light output making it ideal for task lighting. This is the light we normally use over all of our work spaces here at Home Power. In many cases, like reading in bed at night I have found the EL11R to have way more light than I need. Retail cost is around $15.

Light 5
This LED lamp is powered by 117 vac and uses 17 white LEDs. I find that I can easily read at a distance of over four feet from this lamp. Its efficiency is lower than the 12 VDC LED models because of the power supply necessary to change the 117 vac into low voltage DC to operate the LEDs. It is, however, easy to use—just plug it into any 117 vac power outlet. Delta Lights' retail price for this model is $140.

Light 6
This lamp was the brightest LED light I tested. It used 34 white LEDs and delivered 5.6 foot-candles to the light meter. This lamp makes a fine replacement for the Osram EL11R (Light 4 in the test) and consumes less than 1/3rd the power. Delta Light's retail cost is $240 for this light.

Light 7
I have chronic insomnia and wake up and read every night for several hours. Over the years I have tried just about every light imaginable for this service. They are either too bright, not bright enough, or consume too much power. This LED light screws into any conventional medium base lamp fixture and runs directly from 117 vac. Delta Light's retail cost is $75 for this model.

Light 8
This is a standard twin tube compact fluorescent with no reflector. As you can see from the table, without a reflector it is poorly suited to task lighting. I included it in the test because it is commonly used in homes. Retail cost is around $15.

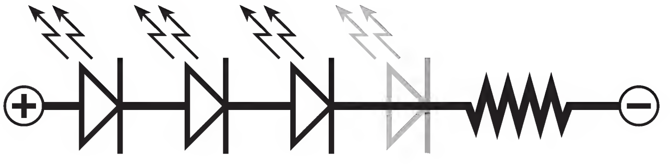
Light 9
This is a conventional incandescent light made by General Electric. I guess that, by this time, everyone knows that the incandescent light is a better heater than illuminator. Well, here is measured proof. Retail cost is less than $1.

Cost
For the data here, it's easy to see that LED lighting is still fairly expensive. The new high intensity LEDs, particularly the white ones, cost between four and ten dollars each. Once you get a collection of a dozen or more of them, then the price of the light is high. Expect prices to come down in the future.

At this time and at these prices, LED lighting is cost-effective primarily in small battery-powered, portable systems. If you are backpacking, or biking, or canoeing, or carrying a flashlight (Delta Lights makes an LED lamp for flashlights priced at only ten bucks), then LEDs are the only lamp to use. If you want to squeeze the maximum performance from your low voltage RE system, then LED lighting can help.

Homebrewing LED Lights
If you want to save some bucks, then consider making your own LED lights. It's very easy. The only hard part is getting ahold of the high intensity LED lamps. Radio Shack sells a fairly high intensity orange LED (RS part number 276-206) for $3.99 each. This LED has a forward voltage drop of 2 Volts and a junction current of 50 mA. The schematic here shows how to put three of these LEDs on 12 VDC power. Simply wire three LEDs in series and use a 150 Ω resistor (RS part number 271-1109) to limit the current through the three LED junctions. If you want to put four of these LEDs in series, then use a 100Ω (RS part number 271-1108) current limiting resistor.

If you manage to get ahold of the new white LEDs you will find that their junction voltage loss is around three



Volts. You can easily construct a series string of many LEDs to run on 12 or 24 VDC. Simply add up the voltage loss of each series junction and subtract this amount from the battery voltage. Divide this figure by junction current and you have the resistance value of

the current limiting resistor. It's really simple Ohm's Law kinda stuff and a great place to start learning homebrew electronics.

Conclusions

If you want the ultimate in efficient lighting, then use LEDs. If you want the ultimate in reliable lighting, then use LEDs. If you want the batteries in your portable light to last as long as possible, then use LEDs. If you want the cheapest light, then buy a light bulb and pay for the energy forever more….

Access

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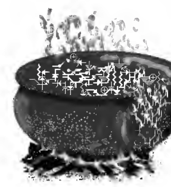
Web: www.homepower.com
Amateur radio: 146.400 MHz simplex

Delta Lights, PO Box 202223, Minneapolis, MN 55420 • 612-980-6503. Delta Light will custom make just about any configuration, color, and intensity of LED light. They also offer low voltage disconnects, photo sensors, and/or motion detectors built into their LED lights.

Jade Mtn., PO Box 4616, Boulder, CO 80306
303-449-6601

Low Voltage Battery Disconnect



Automatic Battery Shutoff For Medium Power DC Loads

G. Forrest Cook

Lead acid and NiCd batteries will last a long time if they are operated within the proper charge and discharge voltages. A charge controller circuit is a necessity for preventing battery over-charge. Conversely, a low voltage disconnect circuit (LVD) prevents excessive battery discharge. By using a combination of both circuits it is possible to keep the battery operating within the proper range.

This article describes a low to medium power LVD which operates like a common on-off toggle switch. The circuit is very efficient, consuming a mere 8 milliamperes while running and essentially no power when off. The LVD was designed to use commonly available parts. The prototype was built entirely from junk-box parts.

Theory

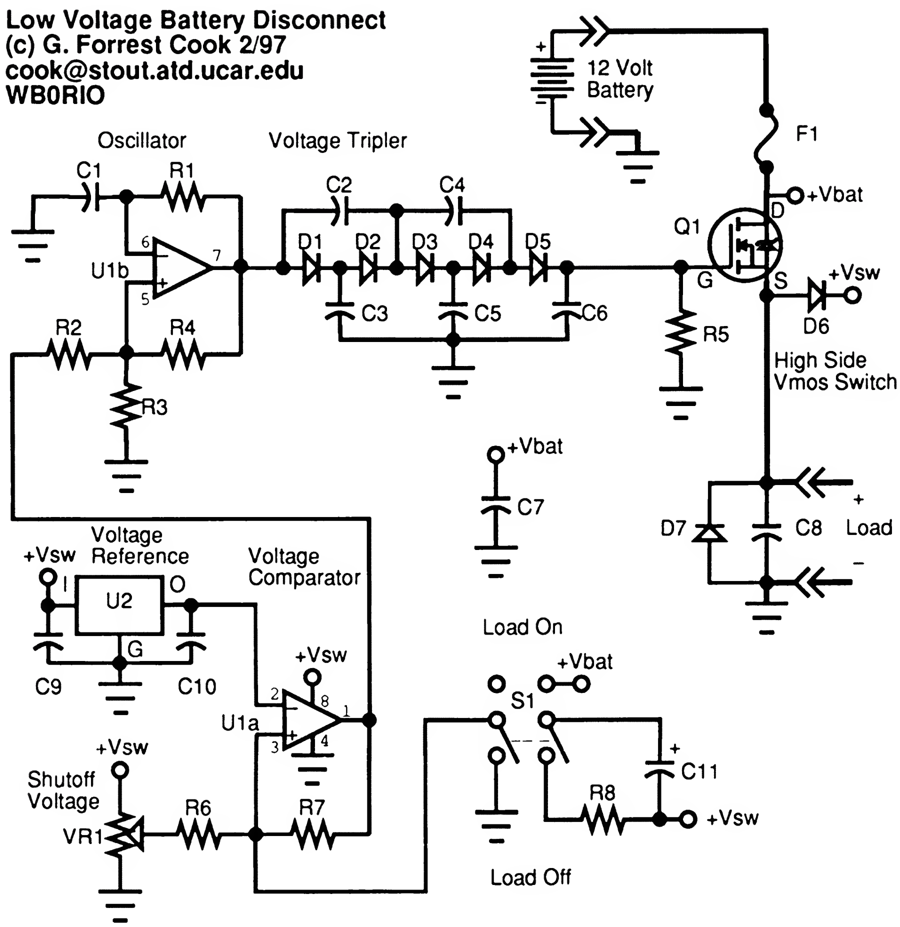
The heart of the LVD is the power MOSFET transistor, Q1. Transistor Q1 operates as a switch in the positive line of the external circuitry. Switching of the positive side of the circuit allows for a common negative ground between the battery and the load which aids in many applications, especially automotive ones. To achieve this "high side" switching, it is necessary to generate a gate drive voltage that is higher than the supply voltage. This is accomplished by a voltage tripler circuit. Op-Amp U1b generates a 5 Khz square wave. This is fed into the diode/capacitor ladder circuit which successively boosts the voltage to about 3 times the peak voltage of the square wave.

This signal is then used to gate on the power MOSFET. Resistor R5 is used to discharge the gate circuit when the LVD is shut off, allowing the MOSFET to turn off. The voltage comparator circuit consists of U2, a standard 5 Volt regulator which is used as a voltage reference, U1a wired as a comparator, and VR1, a voltage divider to provide a set point for the low voltage shutoff. When the battery voltage is above the threshold U1a provides a positive output which is used to create a bias level via the R2/R3 voltage divider, that allows the U1b oscillator to run. When the battery voltage drops below the set point the output of U1a goes to zero and the U1b oscillator shuts off, causing the voltage tripler and MOSFET to shut down. Resistor R7 gives the comparator circuit some hysteresis to prevent comparator oscillation near the shutoff voltage. The circuit is analogous to a solid-state latching relay in that it shuts its own power off when the MOSFET turns off. This is achieved with diode D6 and the on-off switch. When the circuit is switched on capacitor C11 acts like a momentary short-circuit, pulling the op-amp Vcc line up to the battery voltage. The whole circuit fires up long enough to turn the MOSFET on, after which operating current flows through the MOSFET and diode D6.

When the switch is shut off the comparator is forced off by shorting pin 3 to ground. This turns off the MOSFET. Resistor R6 prevents switch S1 from shorting the VCC directly to ground when potentiometer VR1 is set to VCC. Capacitor C11 is discharged through the other half of the switch and current limiting resistor R8. Discharge of the capacitor is required for circuit start-up the next time the switch is turned on. Diode D7 is used to protect the MOSFET from negative spikes generated by motors or other inductive loads. Capacitors C7, C8, C9, and C10 provide filtering in various parts of the circuit.

Fuse F1 protects the circuit from overload and should be a fast blow fuse that is rated at about 80 percent of the maximum current that Q1 can handle. Numerous MOSFET transistors can be used for Q1. Parts selection is based on cost and maximum current. The IRFZ34 MOSFET is rated at 30 Amps continuous current and should be used for switching heavy loads. A lower power MOSFET such as an IRF520 may be used for up to 8 Amp loads. A heat sink and thermally conductive grease should be used on the MOSFET unless the load current is always kept under a few amps.

An alternate method of switching the circuit on and off is to replace the DPDT switch S1 with a pair of momentary push buttons for separate on-off controls. The "on" push button connects between the Q1 Drain and the D6 cathode. The "off" push button connects between U1A and ground. If push buttons are used, capacitor C11 and resistor R8 may be left out of the circuit.

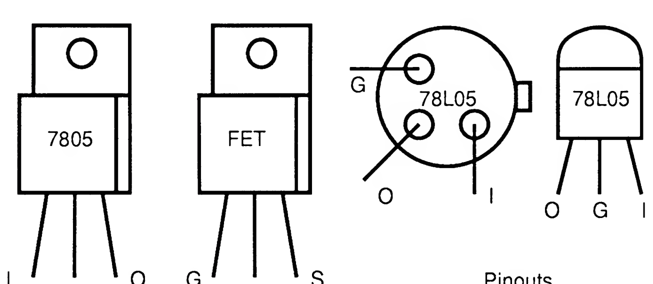


Remember to switch the circuit off and back on while adjusting, it will not turn on by itself.

Construction
I built the prototype circuit on perforated circuit board using point to point wiring. Teflon insulation over tinned bare wire is my personal favorite method for making prototypes since the teflon can withstand a lot of abuse without melting. Wire-wrap or other methods could also be used for construction. Be sure to use thick wires for the current carrying part of the circuit. In the prototype I built the circuit into an aluminum box and used computer DB25 connectors for the input and output connectors.

Use
Simply connect the circuit between the battery and the load and use it like a switch. If the battery sags below the set value the circuit will shut off. After the battery is charged up again the circuit can be switched off and back on. The circuit works well with a 12 V car tail light and a gel-cell battery.

Alignment
Alignment is straightforward, the equipment required is a variable voltage power supply and a load such as a small 12 V light bulb. Connect the power supply to the battery input terminals and the light bulb to the load output terminals. Set potentiometer VR1 to the midpoint and the variable voltage supply to 13 Volts. Turn the circuit on and the light should go on. If it does not, adjust VR1 towards ground and switch the LVD off and back on. Repeat until the light stays on. Then slowly turn the variable power supply voltage down until the light goes out. This is the LVD set point. Adjust VR1 until the shutoff voltage is where you want it to be, I usually set it to 11 Volts for gel-cell batteries.



Pinouts

Battery Capacity Meter
An interesting application for this circuit could be as a component in a battery capacity meter. For the load

LVD Parts List

U1:	1458 dual op-amp
U2:	78L05, 78M05, or 7805 5 Volt regulator
Q1:	IRFZ34 or IRF520
D1-D6:	1N4148 switching diode
D7:	1N4001 1 A diode
F1:	Automotive fuse (see text)
S1:	DPDT toggle switch
C1:	0.001 µF ceramic disk capacitor
C2-C6:	0.01 µF ceramic disk capacitor
C7-C10:	0.1 µF ceramic disk capacitor
C11:	22 µF, 16 V electrolytic capacitor
R1-R4:	100k 1/4 W resistor
R5,R7:	1M 1/4 W resistor
R6:	1K 1/4 W resistor
R8:	22 ohm 1/4 W resistor
VR1:	100K trimmer pot, 10 turn variety preferred

wire a high wattage resistor in parallel with a 12 Volt mechanical clock. Set the clock to 12:00 and charge the battery up. Select a load resistor that gives the desired discharge current. To make a clock that runs on 12 V I used a 1.5 V travel alarm clock with the voltage dropping circuit shown in figure 2. Discharge the battery via the LVD and measure the hours that it ran after the LVD has shut off. This circuit is very useful for sorting through a set of marginal batteries and gives an indication of the useful power that the battery can provide.

Access

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Buying and Using a Digital Multimeter

Richard Perez

A good digital multimeter (DMM) is an essential tool for operating and troubleshooting a renewable energy system. It is your eyes and ears into the invisible world of electricity. Without a DMM you are flying blind.

What is a DMM?

The digital multimeter is a hand held instrument for making basic electrical measurements on a variety of different types of electricity and all electronic/electrical devices. Think of a DMM as an electrical monkey wrench—able to adapt to a wide range of jobs. Modern DMMs pack a lot of electronic smarts into a small package, hardly bigger than a paperback book and weighing far less than a pound.

What can we do with a DMM?

Almost every electrical parameter we might need to investigate can be measured with a DMM. We can measure voltages, current, resistances, and frequencies. These measurements have high accuracy and can be recorded inside the meter. Measurement of these parameters is the first and most essential step in troubleshooting RE systems and electronics in general. Just buying a DMM will not make you an instant expert at electrical troubleshooting any more than buying an electric guitar will make you sound like Jerry Garcia. It takes knowledge and practice to turn a simple measurement into a determination of what's wrong with a circuit.

Voltage—ac & DC

This is the most common type of measurement made with a DMM. It answers questions like battery or PV voltage. Technically we are measuring what physicists call electromotive force (EMF). This is the electrical (electron) pressure which forces electrons to move through an electrical circuit. Voltage is one parameter in Ohm's law and is designated as E in the formula: E=IR. Most high quality DMMs will measure voltages in either direct or alternating currents at from 0.01 millivolts to 1000 volts.

Current—ac & DC
Current is the rate at which electrons flow in a circuit. The unit used for current is the Ampere and it is abbreviated in Ohm's law as I in the equation I=E/R. Most good DMMs will directly measure from 0.1 microAmpere to 10 Amperes. The use of current measuring shunts can extend this capability to over 1000 Amperes.

Resistance
Resistance is the property of all materials to slow down the forced flow of electrons moving through them. Resistance is the third and final parameter of Ohm's law. The unit of electrical resistance is the Ohm, and it is abbreviated as R in the formula R=E/I. Most good DMMs will measure from 0.1 Ohm (Ω) to 40 MegaOhms (MΩ).

Frequency and duty cycle
A DMM can measure the frequency of alternating current electrical power and the duty cycle of direct current pulsed power. The range is commonly between 0.01 Hz and 200 kHz. Duty cycles between 0.0% and 99.9% can be measured with most high quality DMMs.

Semiconductor and capacitor testing
Almost every DMM has the ability to make a "pass" or "fail" measurement on semiconductors such as diodes and transistors. The DMM accomplishes this by running a small amount of current through the semiconductor junction and measuring the junction's voltage loss. This is very handy for component-level electronics troubleshooting. Many DMMs will also check and measure capacitors from 0.0 nanoFarads to 5.0 microFarads. This is also useful for troubleshooting electronics.

What capabilities should the DMM have?
When you go to purchase a DMM, you will be confronted by a variety of features, capabilities, accuracies, and prices. Here's what these specifications mean. Here's what you need and what you don't.

Display
Consider the size of the DMM's liquid crystal display (LCD). Is this LCD backlit? A large sized display is much easier to read than a smaller display. A good backlight is essential if you want to read the LCD in dim light conditions (such as in a battery or generator shed).

Number of digits
A DMM which reads out to 3 and 1/2 digits is just fine for most home power uses. While you can buy a 4 and 1/2 digit DMM, they are much more expensive and it is doubtful that you will need this degree of accuracy. Many high quality, 3 and 1/2 digit DMMs can be kicked into 4 and 1/2 digit mode if required, although the measurement sample time slows way down and the DMM appears more sluggish.

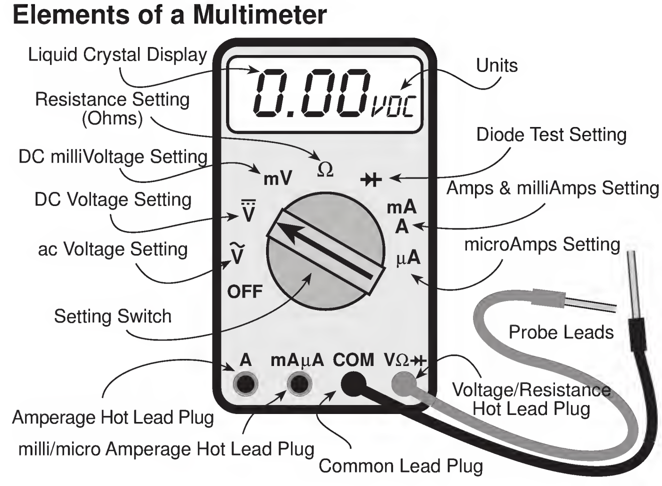
Accuracy
In the world of measurement, accuracy is the name of the game. A high quality DMM will offer voltage DC measurement accuracy around 0.1% and current measurement accuracy of 1.0%. This is computed as plus or minus the % of the reading times the number of least significant digits of the measurement. Measurements of ac electricity have accuracies around 1% for voltage and current. Other measurements will offer differing accuracies: resistance between 0.2% and 1%, frequency around 0.005%, and capacitance around 1%.

Accuracy (and longevity) is what you pay for when you buy a high quality DMM. Is this accuracy necessary? For some measurements such as milliVolt DC voltage drops across a high current shunt, yes, it is. For other measurements such as battery voltage, no, it is not. Remember, that in the world of measurement, accuracy is the bottom line.

Note how long the manufacturer warranties this accuracy. Most good DMMs will guarantee accuracy for a year or more. They will also offer no-hassle recalibration at a reasonable charge.

True rms measurement of ac power
If you are going to be measuring inverter power with a DMM, then having true root mean square (rms) measurement is essential. Most DMMs will measure sinusoidal, 50 to 60 Hz., alternating current electricity with good accuracy. Move to nonsinusoidal alternating current (such as produced by modified sine wave inverters) and the DMM will be very inaccurate (errors of over ±25%) unless it is capable of measuring non sine wave power. This ability is called "true rms" ac electricity measurement. Don't buy a DMM without this capability. True rms measurement is not only necessary

Elements of a Multimeter



for mod sine inverters, but for many other RE devices such as wind generators, hydros, and electronic power converters (such as PWM charge controls, switching supplies, and linear current boosters).

Zeroing
Most good DMMs will allow you to zero the meter's measurement to compensate for noisy readings. Anyone who has ever tried to make accurate ac current measurements in a noisy environment (such as close to an inverter or generator) will appreciate the ability to zero out ambient noise. This noise is mostly radiated ac magnetic fields and can easily affect the accuracy of any ac power measurement.

Zeroing the meter before making resistance measurements will neglect the resistance of the DMM's probe wires and their connectors. This gives more accurate resistance measurements.

Recording—minimum, maximum, and average
Being able to record measurements is a great feature. It is essential for: finding intermittent problems, using the DMM (with a watch) as an ampere-hour meter, making accurate average measurements on varying sources (such as wind gennys), and many other measurements. This recording function is essential for measuring rapid power surges such as those encountered when starting and running electric motors. Most high quality DMMs will record data for at least 32 hours and some until the DMM's battery is totally discharged. The average measurement is a true, integrated, arithmetic average, (not just the highest reading plus the lowest reading divided by two). Minima and maxima readings can be captured at speeds of 100 milliseconds and 1 millisecond. This allows accurate measurement and recording of very fast current and voltage surges.

Buying your DMM
You may have noticed that I've been saying "high quality" a lot in this article. I become attached to my tools. I learn how to run them and take care of them. Consider that the DMM is your most basic electrical tool. When you learn to really run it, you will come to depend on its information. Don't fool around with junky meters that have bad accuracy and short lifetimes. Buy and learn to use an accurate and long lived DMM. It's cheaper in the long run.

Brands
I have years of experience with two brands of DMMs—Fluke and Wavetek (formerly Beckman). Both are what I consider the minimum meter for anyone who is really going to use it. I own three Fluke 87 DMMs and one Wavetek 2020 DMM. Both have all the desirable features. I know that other brands (such as Tektronics) are available and may be just as good. I simply don't have hands-on experience with them. In my experience, the Fluke 87 has higher quality mechanical fittings which ensure long life without mechanical failure in simple stuff such as the switches and probe sockets. You can buy DMMs everywhere from Radio Shack to mail order catalogs. Shop around for a good price on a high quality meter.

Price
OK, here comes the bite. If you aren't spending at least $200 for a DMM, then you are wasting your money. The DMMs which cost under $200 are less accurate and much shorter lived than those which cost more. The Wavetek 2020 costs around $250 and the Fluke 87 costs around $325. You get what you pay for. One of our Fluke 87s is over seven years old now and everything still works. Accuracy on this meter still checks out with our newer meters. Why do we at Home Power need all these DMMs? When we test inverters, we need to make simultaneous, accurate, measurements on DC volts, current into the inverter, 117 rms voltage, and current out of the inverter in order to compute inverter efficiency.

Probes
Every DMM comes with one set of two probes. Each has a banana plug on one end (goes into the DMM) and a long handled, insulated, pin probe (goes where you are making the measurement). The wires for these probes are usually about three feet long. I usually cut this factory probe set in half because 18 inch long probe wires are just about right for most applications. I attach a banana plug to the bitter end of the pin probes and a small alligator clip on the bitter end of wires with the factory banana plugs. This gives me two sets of probes. I mostly use the alligator probes because you can clip them to just about anything which is not soldered to a printed circuit board. The alligator clips leave your hands free.

Just plain wires are not the only types of probes you can use with a DMM. We have a variety of electronic probes here at Home Power, but we only use two on a regular basis—temperature probe and clip over ac/DC current probe. Both are active probes, i.e. they both have their own electronic circuits and their own battery. The temperature probe is very accurate and we use it to measure back of PV module temperatures, and solar heating/cooking temperatures. The current probe allows measurement of either ac or DC current without breaking into the circuit. Simply zero the current probe, clip the current probe over a single wire, and read the current on the DMM. This is very useful for making current measurements and troubleshooting on large batteries, inverters, PV arrays, and wind generators. While not as accurate as breaking into the circuit, it is

far more convenient. Both these probes use the DMM to make the actual measurements and display the information. A good temperature probe cost around $75 and an ac/DC current probe costs around $250. Both will work with the recording functions of the particular DMM.

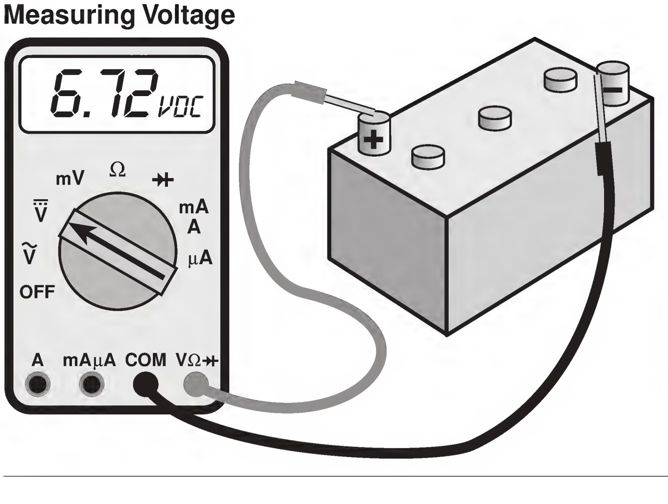
Using your DMM
First off, read the user's manual thoroughly. Learn the limitations of the instrument and stay within them. For example, if you run more than 10 Amperes of current through most DMMs, then you will blow an expensive and hard to find fuse. Current measurement on all ranges is usually fused with very special slow blow fuses. Most DMMs are now using a microprocessor. While there may only be a few buttons on the dashboard, there is a computer under the hood. A quick read through the manual will show you how to operate the DMM's advanced features (such as recording, peak voltages, zeroing, and 4 and 1/2 digit mode).

Understanding the laws…
Without a good working understanding of Ohm's law, a DMM is just an expensive toy. Cozy up to the concepts involved in Ohm's law until they become second nature to you. This is the Golden Road to Electrical Troubleshooting. E=IR is the law, learn it and the info from your DMM will find most electrical problems. For a quick course in basic DC and ac electricity, see HP #52 and HP #53.

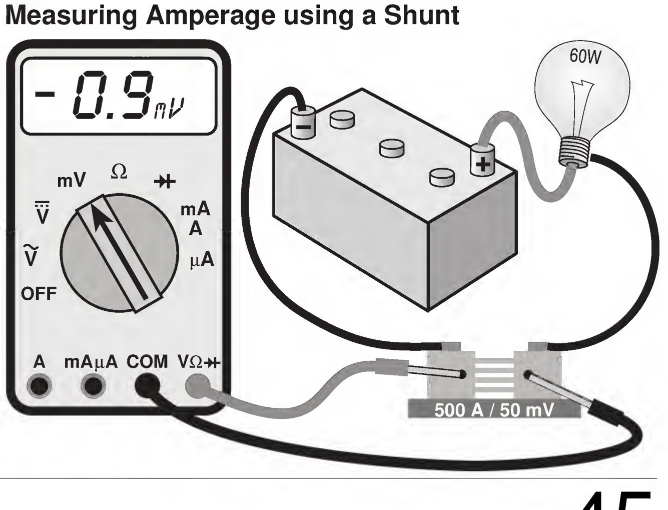
Measuring batteries—voltage and current
Voltage measurement of lead-acid batteries is probably the most common use of a DMM in renewable energy systems. The battery we use in home power systems is usually composed of individual 6 Volt batteries or even individually cased cells. These smaller batteries, or cells, are assembled by series and parallel wiring into the main battery. Routinely checking the voltage of individual cells, or of the batteries, which make up the main battery pack can spot battery problems before they ruin the battery. All the cells, or small batteries, should have the same voltage. If one six volt battery is more than 0.15 VDC lower than the others, or if an individual cell is 0.05 VDC lower than the other cells, then it's time to run an equalizing charge. Just measuring the entire battery's voltage is not enough, the inequalities between cells will not show up on gross voltage measurement until the cells become very unequal.

Most RE batteries are so powerful and most currents so high that current measurement is always made by a shunt. A shunt is a precision amount of resistance placed in series with a high current circuit. For example, most systems are now using system instrumentation employing a 500 Ampere/50 milliVolt shunt in series with the battery. This shunt has a resistance of 0.0001Ω. Ohm's law tells us that for every Ampere of current flowing through the shunt, a voltage drop of 0.1 milliVolts will occur across the shunt. It is in this type of measurement that high accuracy in the DMM is really worth the money. The actual measurement process is as follows. Insert the probes in the DMM's DC voltage measure holes, select milliVolts on the dial and attach the probes across the battery shunt. For every 1 Amp of current flowing through the shunt, the meter will measure 0.1 mV. Shunts also come in 100 Ampere/100 milliVolt models (0.001Ω). In the field when I didn't have a shunt for troubleshooting, I have used 1 foot of #10 gauge copper wire.which happily enough has a resistance of 0.001Ω. Here this copper wire shunt will indicate 1.0 mV for every Ampere of current flowing through it. While the shunt doesn't have to have a resistance which is a decimal fraction of one, it does eliminate the need for a calculator to run the math through Ohm's law. Simply move the decimal point. Shunts allow us to measure large currents without having to place the DMM in series with the circuit.

Measuring Voltage



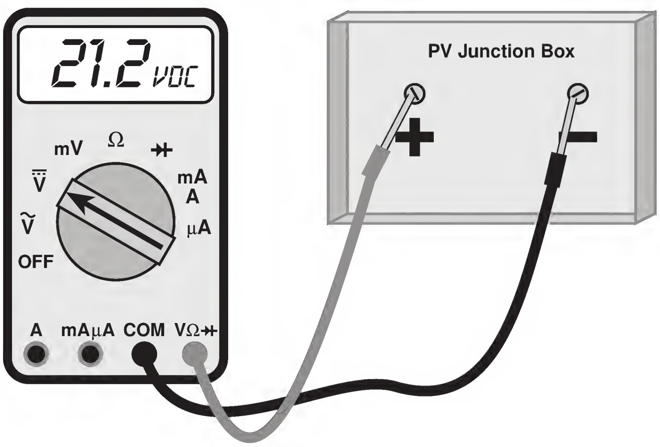
Measuring Amperage using a Shunt



Measuring RE power sources (e.g. PVs)
A DMM is an excellent tool for checking the general health of photovoltaic modules. With two simple measurements we can determine if the module is meeting two very important specifications—open circuit voltage and short circuit current.

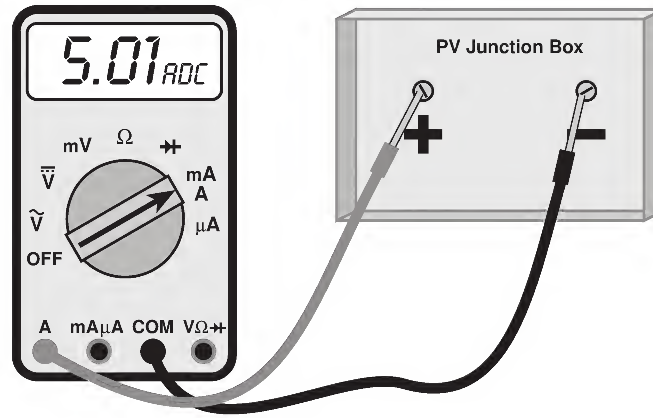
To measure open circuit voltage on an active (in full sun) PV module do the following. Open the module's junction box and disconnect all the wires from either of the module's plus or minus output terminals. Set the DMM to measure voltage and connect it across the positive and negative PV output. In many modules, the open circuit voltage (at 25°C) is printed on the back of the module. If the module is hot (50°C or more), then this voltage may be a 2–3 VDC lower than the spec printed on the PV's backside. If the open-circuit voltage is more than 4 VDC lower than spec, then the module has problems.

Measuring Open Circuit Voltage



While you have the module disconnected from the rest of the array, you can also check short circuit current. Since most modules produce less than 10 Amperes of direct current you can measure this current directly with the DMM. Set the DMM to measure current in the 10 Ampere range and connect it across the positive and negative PV output. Short circuit current (Isc) is usually printed on the back of the PV module. You should see this rated value. Heat does not play a factor here, in fact PV short circuit current actually increases when the module gets hot. If your measured short circuit current is less then 90% of rated, then it's time to send the module back under warranty. Most PVs are warrantied not to have a power loss of more than 10% within ten to twenty years. If you suspect that your modules have problems (as in they don't seem to produce what they used to) then check the open circuit voltage and short circuit current. Chances are that if there are problems with the PV portion of the system, it will be in the wiring and not in the actual modules themselves. Virtually no one has been collecting on PV warranties.

Measuring Short Circuit Current

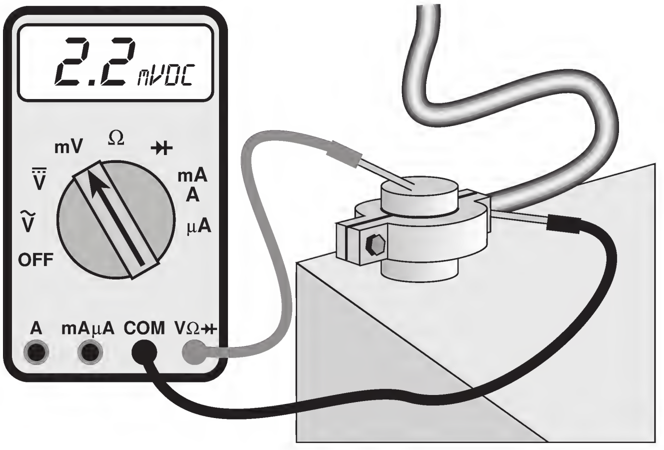


Measuring 120 vac engine generators
Use caution when measuring any voltage (ac or DC) over 40 volts. If you make yourself part of the circuit, then you will get an unpleasant shock. I use a homemade probe to measure voltage in 120 vac circuits. It is simply a three prong male plug (called by electro weenies a "cord cap") with three bits of short stiff wire coming out the back. I attach the alligator probes running to the DMM to the bits of wire sticking out of the plug. If you make a lot of 120 vac voltage measurements, then make up a probe with a standard male plug on one end and two banana jacks on the other.

There are three measurements to make which tell you if your 120 vac engine generator is up to snuff—rms voltage, peak voltage, and frequency. The rms voltage should be 117 vac ± 5%, the peak voltage should be 164 vac ±10%, and the frequency should be dead on at 60 Hertz. If rms voltage and frequency are both low, then the generator is spinning too slowly and needs to have its speed (RPMs) increased. If frequency and rms voltage are too high, then decrease the speed of the generator. If the peak voltage is below 150 volts and rms voltage below 105 vac, then the generator is being overloaded. Recording peak voltage often answers questions such as: "Why does my battery charger, pump, or electric motor only put out 70% of rated when powered by the generator?" Chances are that the generator is having trouble providing the peak voltage required and this can be determined by recording peak ac voltage while the appliance is operating.

Measuring inverters
You can make all of the same tests described above for generators on inverters. The specifications for rms voltage, peak voltage, and frequency remain the same. If the inverter won't start and run big loads (usually

Finding Bad Connections



electric motors) then check out peak voltage. Chances are that it is falling below specification when the inverter encounters a load demanding high power surges.

Finding bad connections
Finding bad (as in open circuit or resistive) connections is easy with a DMM. Every connection in a circuit is designed to pass electricity, so it is supposed to have very low resistance. From Ohm's law we know that the voltage lost across a connection is equal to the amount of current flowing through the connection times the resistance of the connection (E=IR). Set up the DMM to measure DC milliVolts (in DC circuits) or ac millivolts (in ac circuits) and measure the voltage across a connection while current is flowing through the connection. Voltage loss across a mechanical connection should be no more than a few hundredths of a volt. If you are seeing 0.5 volts or more drop across a connection then it's highly resistive and needs repair. This technique is invaluable for finding bad connections on batteries and PV arrays. Remember that current must be flowing through the connection for this technique to work.

Testing for continuity
Most DMMs have what is called a continuity tester. This feature is great for finding blown fuses, bad plugs/sockets, and broken wires. Simply setup the DMM for continuity testing and attach the probes to what is supposed to be a complete circuit. If you have continuity then the meter beeps, if not it remains silent. Perform this test on dead (i.e. disconnected from all power sources) circuits.

Testing for polarity
Ever hooked up a DC appliance reverse polarity? This is usually spectacular and destroys the appliance. DMMs will indicate polarity in DC circuits. If you have been foolish enough to not clearly identify polarity on your wiring, then measure it to determine polarity before hooking up any DC gear. The DMM will tell you which wire is positive and which is negative. The same is true for any DC power gear such as PV modules, power supplies, wind gennys, and hydros. I always double check polarity even when the wiring has been color coded. After all it's easy to make a mistake and it only takes milliseconds to destroy an appliance by subjecting it to reversed polarity power. The DMM knows positive from negative and you can count on it.

Troubleshooting electronics
A good DMM is the basic tool for component level troubleshooting of electronics. In over twenty years of repairing electronics I have found that over 90% of the problems were simple to find with a DMM and Ohm's law. For example, if the stereo goes dead, then check the obvious stuff first. Chances are it is unplugged, has a bad power cord, or other easy to find and fix problem. Trace the path of power and signal through the device. If it suddenly stops, then you've found the problem. Most problems are simple to fix: bad mechanical connections, dirt in the mechanisms, and such like. Don't be afraid to check out electronics thoroughly before sending them out for repair by experts. The only exception to this rule is electronics which are still under warranty. Here, even opening up the case will void your warranty.

Caring for your DMM
If you've purchased a good DMM and went to the trouble of learning how to use it, then protect your valuable tool. Here's a few tricks I've learned. Follow these tips and your DMM will last a very long time. Disregard these ideas and you can ruin the instrument in a matter of months.

Case
While most DMMs come with a rubber sock to protect them from shock, you will still need to protect them while they are in storage and transit. The cheapest and best case is a foam padded ammo can. Ammo cans are cheap, waterproof, and very rugged. Buy an ammo can that is large enough to hold the DMM, a spare battery, spare meter fuses, and a good sized collection of probes. Line the ammo can with scraps of foam rubber glued to its interior. Such a case will protect the DMM even if it is hauled in the back of a pickup, over a bumpy road, and in a heavy rainstorm.

Hang-up string
I have added a short hang-up string to my Flukes (the Wavetek already has one from the factory). Hanging up the meter means that jerking on a probe wire will not cause it to fall from where it is positioned. This has saved my DMMs from taking many a crash to the ground.

Batteries
Most DMMs use a standard 9 Volt transistor radio battery. (NEDA 1604 or 6F22 or 006P). These batteries will last about 400 hours of operation (less if the DMM is used for extensive recording or has high display back light usage). Buy the best alkaline battery you can find. Don't fool around with lower capacity batteries. In order to replace the battery in a DMM you must open its case. This means removing three or four screws. These screws are usually of the sheet metal type threaded into plastic. Overtightening these screws will strip out the threads in the plastic. Use caution. Never leave a dead battery inside the DMM. Either replace it or remove it. Totally discharged batteries can leak and damage the electronics inside the DMM. Most DMMs have a low battery warning, heed it! Always carry a spare battery in your DMMs ammo can case. There are few things as frustrating as arriving at a site to troubleshoot with a dead DMM.

Moisture
Keep your DMM dry. In fact, I like to put a small packet of silica gel (comes packaged with most bits of electronics) inside the ammo can to absorb moisture. Put the silica gel pack in the oven at 250° F for an hour every six months or so to make it release its stored moisture. Should your DMM become wet, or should you submerge it in water, remove the battery and place the DMM in a warm, dry location for several days to dry it out. Usually there is no problem. Do not try to make measurements with a wet meter. This can damage the meter and be dangerous to you.

Temperature
Keep your meter cool (at room temperatures). Leaving the meter on the seat of a car during the summer can cause it to become very hot. This may ruin the LCD and cause the battery inside the DMM to leak. Don't store your DMM in the trunk of a car—it gets really hot there during the summer. Cold is usually not a problem with DMMs, although they are inaccurate and sometimes don't work at all if they are very cold. Everything is usually fine once the meter warms up to room temperatures.

Calibration
If your meter is over three years old test it for accuracy. If inaccurate have it recalibrated by the company that made it. I routinely check all our meters against each other and, in over seven years, have not found one that actually required recalibration.

What a DMM can't do
A DMM is not a renewable energy system monitor. It is not designed to be a battery Ampere-hour meter, although it can be used as such. It is not designed to monitor your system's functions all day, every day (think of the pile of batteries it would use). It is designed to make accurate measurements which give you the clues you need for troubleshooting. Use it wisely and you will know all.

Access
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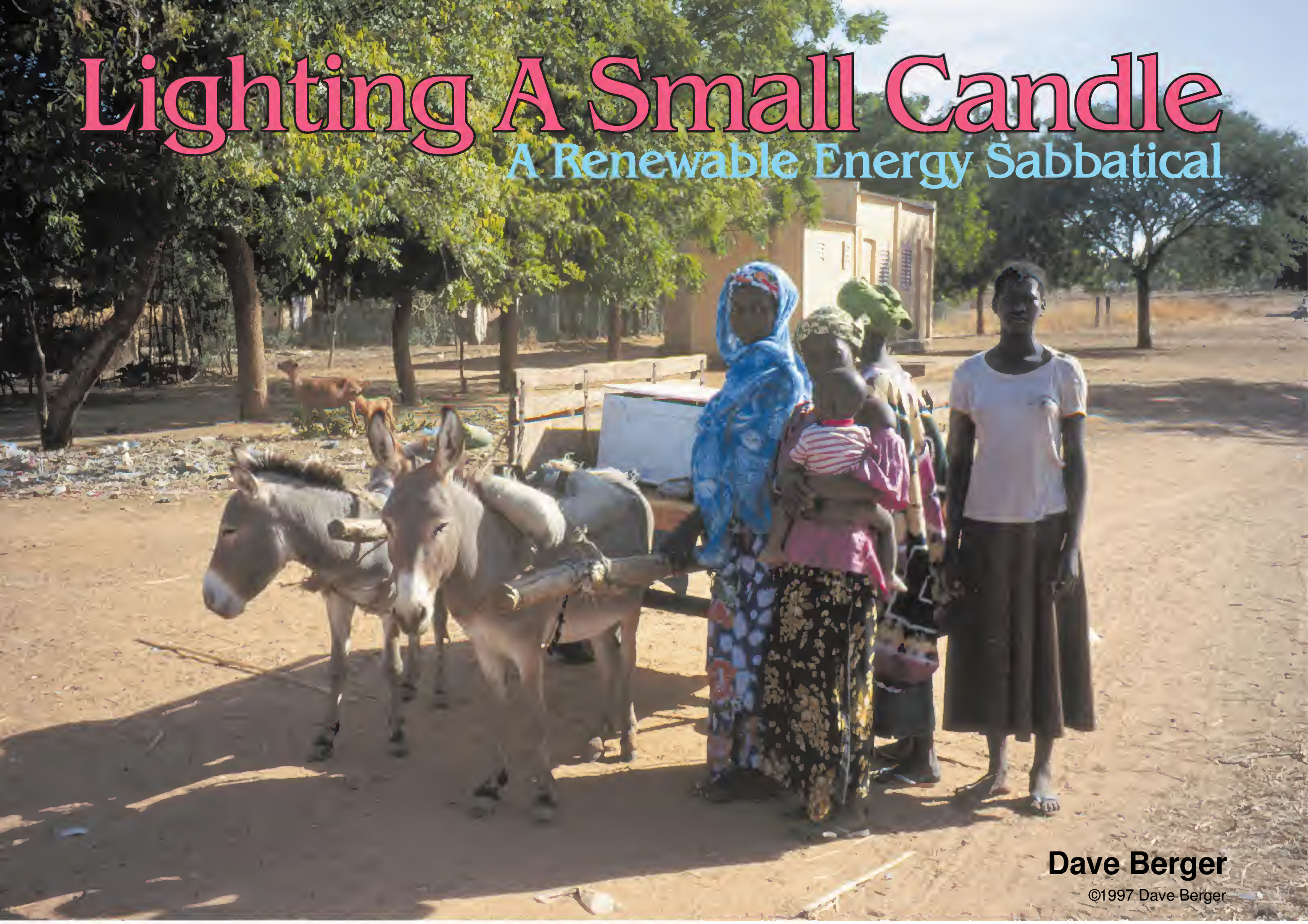
Amateur radio: 146.400 MHz simplex, call N7BCR

Lighting A Small Candle

A Renewable Energy Sabbatical



Dave Berger

Above: Representatives from a womens' collective take a solar cooker home in a donkey cart.

Several years ago I heard a very dedicated United Nations worker speak about environmental and health issues. She said she had spent many years complaining about the problems in the world. One day she realized her energy would be better spent trying to work for an improved world rather than sitting in the dark and "bitching." So she decided to join the United Nations and "light one small candle in the dark" rather than sit and complain.

This talk truly inspired me and the complaining part struck home. When I proposed my sabbatical project for the 1995–1996 academic year I emphasized lighting a candle in the dark by focusing on implementation of renewable energy projects. My employer, Portland Community College, has always had a wonderful track record in supporting student and community projects. They accepted my proposal. I was released from my normal teaching duties for one year with partial salary.

Solar Energy International

Perhaps the best thing to come of the year long adventure, was the thoughtful, caring people I met and the friends I made. The Solar Energy International teaching staff gave me and a small group of students unsurpassed classes in photovoltaics, wind, micro-hydro, and solar cooking.

With the help of SEI staff we 1) selected a solar box cooker design for a project in Mali, West Africa, 2) received a grant from the Northwest Environment and Self Reliance Trust for educating future SEI students in renewable energy, and 3) developed a list of materials to take to Mali.

The cooker design was a simple rectangular box. The materials taken included an electrical meter, a camera, a compass, a site level, a measuring tape, rubber gloves, a solar powered battery charger with batteries for a flashlight and short wave radio, a "Leatherman"

tool, and oven thermometers. I brought a completed solar cooker prototype without glass, a sketch pad, and wapi pasteurization indicators for solar cookers.

Above: Strawbale test structure at Portland Community College.

Strawbale Research Facility
At PCC I worked with an extraordinary group of students and volunteers on the "Strawbale Project." We designed and constructed a 10 by 12 foot exterior shed with a passive solar south facing window, concrete slab foundation, insulated metal roof, and strategically placed moisture monitors in the bales. We are upgrading the facility to include photovoltaic (PV) power for lighting, monitoring, humidification and water pumping, a propane heating system, a solar hot water system, and a computerized data acquisition system. One purpose of the project is to provide a demonstration of renewable energy. We are also testing the viability of strawbale construction in the moist Pacific Northwest.

Mali Solar Cooker Project
The solar cooker project was the heart of my year long experience. It was managed by myself and another Oregonian, Lassine Niare, a native Malian who is fluent in Bambara, the prevalent language, and French. Lassine is committed to helping his country.

The objective of the project was to plant a small educational seed for solar cooking. The goals were to reduce CO_2 emissions (rough estimates were for reductions of 6.1 tons of CO_2 per cooker per year), diminish on-going deforestation, reduce desertification potential (Mali is virtually the doorstep of the Sahara), protect wildlife habitat and local vegetation, provide a smoke free environment, and save people the money usually spent on fuel.

The philosophy we applied was 1) use local materials to insure sustainability, 2) have a local person at all times to deal with cultural implementation issues, 3) train locals to build cookers, 4) hold cooker training classes for recipients, 5) distribute cookers to various individuals, groups, and locations to spread the seeds of

Left: The President of Mali (in purple), Lassine Niare (second from right) with tribal elders and a solar box cooker.

Above: Solar cooker training in Banamba, Mali.

knowledge, 6) develop a follow-up evaluation mechanism, 7) test samples of cookers for quality before distribution, and 8) provide a completed prototype.

We chose a simple flat box cooker design to accommodate Mali's 12°N equatorial latitude. We decided to use wood for the box to insure sustainability, two pieces of glass to insure a warmer cook and allow the cooker to continue to function if one was broken, a black metal base plate for better heat conduction, cardboard insulation, aluminum foil interior lining, and an aluminum-covered wood reflector. The exterior of the box was 30 by 75 by 85 cm. The size of the typical Mali cooking pot was considered.

Implementation

We arrived in Bamako, the capitol city, and contacted the materials manufacturers, our lead carpenter, Binafu, and his crew. Binafu's crew built all the cookers that we distributed in Bamako and prepared all the kits disbursed in rural areas. Our costs for 98 cookers averaged about $78 each including parts and labor. During the three months that we were there we employed approximately 50 locals for fabrication and disbursement. Countless other local jobs were assisted by the manufacture of the materials we used. We had positively contributed to a local economy of one of the poorest countries in the world. Almost everyone we worked with had large families, was extremely cooperative, and truly welcomed the work. We chose to train only carpenters in cooker fabrication because they owned tools, and their skills assured quality work and timeliness.

We disbursed our cookers with numerous collectives, government organizations, and agencies to spread as many seeds as possible for solar cooking.

Our three major disbursement sites were Banamba, Bamako, Yanfolila, and the Peace Corps. Banamba was the ideal development site. We had support from two environmental managers with the Bureau of Water and Forestry. They connected us with the local radio station which was PV powered by a grant from Plan International, a USA development organization. Even Banamba's water supply and grocery store were PV

Dave's Sabbatical Schedule

Activity	Location	Time Frame	Status
Training	Solar Energy International, Carbondale, Colorado	June–October 1995	Complete
Construction of Straw Research Facility	Portland Community College, Portland, Oregon	June–October 1995	Phase I complete Phase II upgrade in progress
Implementation of Solar Cooker Project	Bamako, Banamba, and Yanfolila, Mali, West Africa	November 1995 –April 1996	Fabrication and distribution completed Evaluation in progress
Assisted on Solar Electricity Project of Masai Organization	Terrat, Tanzania, West Africa	May–August 1996	Project is ongoing

Cooker Distribution

No.	Location	Recipients / Purpose
1	Bamaco	Prototype made in Portland, used only as a model for local carpenters.
15	USA Peace Corps	Used by USA Peace Corps volunteers to introduce solar cooking in rural villages.
8	Bamako	Placed with individual families and a women's co-op that may be easily monitored and has shown interest in the project.
1	Kaye	Placed with an individual interested in environmental protection.
5	NGO's	Given to non-governmental organizations having interest in energy and environmental issues, and access to areas of northern Mali plagued by desertification.
27	Yanfolila	Placed with individual families, the hospital, the school, a group fighting deforestation, and women's collective. The local branch of the National Bureau of Forests & Water, (Mali's EPA) placed 10 cookers in rural locations via 4-wheel drive. The local circle for county government placed 9 in rural locations.
21	Banamba	Given to women's collectives, solar energy advocates, and environmentalists. Placed with the assistance of the local branch of the National Bureau of Forests & Water and the local solar-powered radio station.
20	Bureau of Forests & Water, and National Dept. of Energy	Placed for nationwide distribution to spread the solar-cooking concept in order to prevent desertification and make popular the use of the sun for cooking.

powered. Banamba was no stranger to development projects, already familiar with renewables, and very receptive. At the radio station we placed four short ads in the local tribal language, and received a 30 minute interview for Lassine in Bambara, a national language. This and support from the local government and community elders resulted in solar cooking training sessions for about 500 people. We cooked rice, beans, potatoes, sauce, meat, and garlic. At the doorstep of the great Sahara, our cookers reached 265˚ F in the low January sun. It was a clear day and our cookers registered 150˚ F even at sunset. We trained two engineers as cooking trainers. One, Mamadou, said that he would cook every day during the ten month cooking season and save 2 to 3 cubic meters of wood a month valued at $17. A substantial savings considering that his salary is $140 per month. It was here that I experienced one of the most wonderful moments of the project as three women from a local women's collective took two cookers off into the sunset in a donkey cart.

Yanfolila was a site which provided good local support from government agencies and individuals. After placing our first six cookers we were forced to leave because I needed treatment for dysentery. We were not able to return for a month. But when we returned, two cookers were in use in the street cooking cassava and tea and preparing the traditional feast that marks the end of fasting during Ramadan. Two of the six is a small sample and may not seem very successful. However, based on information I later read in a report by Mark Hankins of Energy Alternatives Africa, Ltd. and based on small samples of cookers, it may actually be a high success rate. In fact, much of the literature and information supplied by solar cooking enthusiasts doesn't supply any follow-up evaluation information at all. This is a major flaw because simply placing cookers doesn't mean they are being used. Lassine and I developed follow-up surveys that address cooker use and design and he is back in Mali gathering these surveys.

Another noteworthy event happened in Yanfolila. My fiance, Julie Larson came for a visit and led a solar baking session, during which she baked bread in the oven with several women. It appears that the local women were more motivated or comfortable with a woman trainer.

Bamako was our headquarters and the nation's capitol. It has terrible air pollution from autos, dust, wood smoke, and fossil fuel burning. Plastic garbage is everywhere and smelly open sewers line the streets. Yet, it is a place of hope, a country that threw out its dictator six years ago. It has a democratic government that allows political freedom and is building new roads

Above: Lassine with cooker frame.

and attempting to clean the streets despite the county's widespread systemic poverty. Bamako served as an excellent home base to us because 1) it is a manufacturing center, 2) imported glass and aluminum foil are readily available, 3) Lassine's father, Baba Niare, is the traditional chief of this city and he has numerous connections and over 600 years of family lineage, 4) there are over 600 non government organizations in Bamako, and 5) it was wonderful to come home to Lassine's house and play with the children there. We made contact with numerous organizations and skilled laborers, held training sessions, established our infrastructure, and even got some local media coverage.

In an attempt to insure follow-up and training we gave approximately 15 box cookers and one specially made large cooker for a women's collective bakery to the Peace Corps. We trained a Peace Corps manager/trainer in the use and fabrication of the cookers. Their volunteers were very receptive and wanted more cookers than we could provide. It seems many of their volunteers have undirected projects without funds or even no projects, and were happy to work with the solar cookers. As the Peace Corps already had some success with charcoal cookers in Mali we were hopeful that they would be a good vehicle for the spread of solar cookers.

Problems

There are some problems we encountered. Families in Mali are extremely large, up to 20 people, requiring huge cooking pots. Glass was hard to find and unavailable in some rural areas. The roads are very rough making it difficult to transport without breaking. In some areas termites threatened the wooden boxes. Cooking time is much longer with the sun than with wood. The standard cooking pot is very dense and heavy as it had been designed to cook on an open fire. We gave cookers to smaller families of ten or less. We recommended that available lightweight aluminum pots be painted black on the exterior to be used in the cookers. We suggested that the cookers be stored off the ground for termite protection.

To address concerns about the glass we experimented with a parabolic design. Logi, the local satellite dish fabricator, had the skills to produce the frames by pounding out a rectangular shaped metal bar with sand inside of it. Perhaps a second phase would have Logi create a sustainable business by making copies of the German SK12 parabolic stand and importing the polished aluminum reflective material needed. The parabolic needs no glass and can boil 3 liters of water in 30 minutes. Reducing the cooking time would create a greater incentive for the locals, especially women who already work up to 20 hours a day.

Other Renewable Needs

You name it, Mali could use it. Coming out of a repressive political era isn't easy. PV could be used for lights, water supplies, radios, and small battery charging systems. More hand pumped well systems could be developed. Locals use wood to heat water for showers. We tested a simple 20 liter black plastic can, filling it with water and setting it out in the daytime sun. The solar heated water had to be cooled in order to provide evening "bucket" showers for 4 to 5 people!

Masai Solar Electricity Project

The final phase of my sabbatical was with a Masai human rights organization, Olkonerei Integrated Pastoralist Survival Program (OIPSP). The Masai and their current day situation is akin to the Native Americans two hundred years ago. They are fighting to hold their lands while educating their people. But they are developing renewable energy in rural areas.

OIPSP's work for the Masai in rural areas provides legal and paralegal training on land use and human rights issues, implements solar electricity projects, maintains a veterinarian training center, develops small businesses and housing, provides education on environmental damage from multi-national mining projects and other exploitive endeavors, develops

international alliances in the theater of public opinion, and seeks funding for their cause and projects. In the past they have received assistance from Dutch, British, American, Irish, and Canadian organizations.

I assisted on PV project maintenance at their largest site in Terrat and Simangero, attempted to restore some very old 2 Volt 150 Ah utility cells (using EDTA with slight success), assisted in evaluating potential wind and water projects, attended meetings on human rights and solar planning, assisted in installing some new lights, wiring, PV, and radio phone equipment, trained technicians in using hydrometers and a sight level, and toured past projects including a defunct wind powered water pumping system, a defunct vaccine refrigerator, a large agribusiness, and a gem farm.

Above: Eva, solar tech. of Masai, with three types of lanterns.

OIPSP has many small PV systems in place. Typical systems included 33 to 55 Watt panels, 80 to 150 AH Exide truck batteries, compact fluorescent lights, and Solatec charge controllers set for an LVD of 11.9 Volts.

Problems that I observed with the PV projects were 1) undersized wiring was forcing consistent LVD during the cloudy season at their human rights center in Terrat, 2) the set LVD level protected the compact fluorescents but LVD was happening often indicating that battery life was in jeopardy, 3) the batteries were not high quality, deep cycle (no quality manufacturer existed locally) and would not last long presenting a disposal problem (no recycling center exists in Tanzania), 4) expensive hand-rotated PV trackers were being used with 2 panels instead of the 4 panels that would make the trackers cost effective, and 5) expensive PV powered lanterns were being tested with small capacity batteries that ran down as a result of people running lights too long.

Some of the future renewable energy needs for OIPSP include 1) upgrade some existing PV systems by increasing wiring sizes, test different charge controllers, obtain better batteries, and perhaps develop in-the-field acid neutralization techniques for battery fluid, 2) repair the wind powered water pumping system at Naberera, 3) replace or repair a small BP solar fridge at Moipo used for vaccines for polio, typhoid, tetanus, diphtheria, TB, and measles medicine, and 4) continue to train technicians in renewables. Fortunately, OCF, with the help of SEI, is funding two full scholarships for sessions on renewables for technicians Lukas Sanango and Eva Saineye.

Return to the Past

While in East Africa I returned to Shabwali Secondary School in Western Kenya where I was a volunteer teacher eight years ago. I wanted to follow up on a water supply/rainwater catchment system for the school that had still been in the planning stages when I left. I had designed it with headmaster George Mbele and the local Peace Corp volunteer with funding through a US AID grant. The system had been successfully implemented and built at triple the design capacity as a result of strong community participation.

You never know if projects you work on or things you try will be successful. Who knows whether the Mali solar cooker project will work at all? I am convinced that our efforts are worthwhile, even if it is to learn how not to do things in the future.

Epitaph

In the Dogon country of Northern Mali, I saw a small PV setup lighting a table in a school at night because a Dutch traveler carried it in on his back. Perhaps it won't be sustainable. At least people can read at night for a while since they must work all day. If they can get replacement batteries, they may read for a very long time. They now know about the concept of solar energy, which is good because they have an abundance of solar fuel.

Julie Larson came for a visit and found a 20 year old man chained to a post in his village on the Ivory Coast because of his mental illness and episodes of destructiveness. His family could not afford the medication that would relieve his symptoms. Julie is a social worker and arranged for assistance from a local doctor with the aid of a Peace Corp worker. She raised funds when she returned home by contacting fellow social workers to help provide his medication at cost of about $20 a month. Guess what? He is now on medication and unchained, his life sentence at the post has ended. That little "candle in the darkness" was truly lit.

In Closing

I want to thank everyone who educated, helped, funded, and befriended me through these projects. Special thanks go to Lloyd Marbet, a lifelong environmental and social justice advocate.

Access

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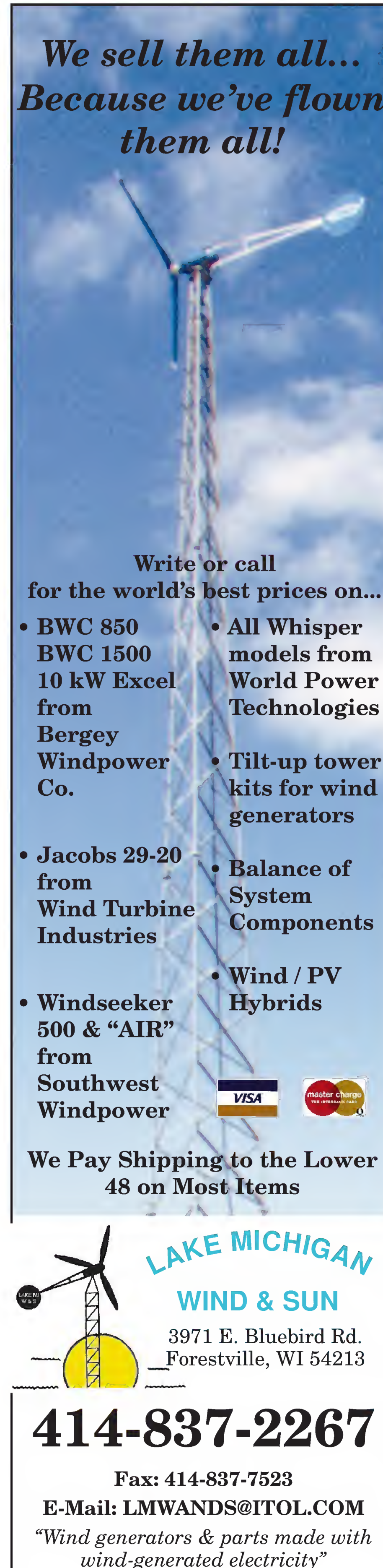
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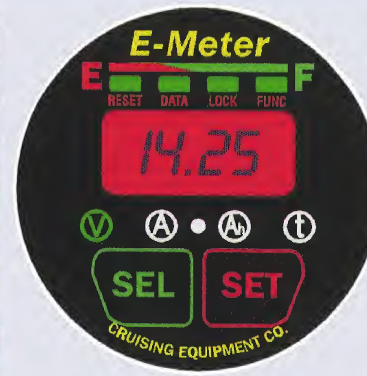

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The Long, Long Road of Solar Racing

Shari Prange

In 1987, worldwide attention focused on the vision of one man. Inspired by Paul MacCready's Solar Challenger aircraft, Hans Tholstrup organized the World Solar Challenge, a solar-powered race across Australia, and spawned a new category of racing: the transcontinental solar race.

This type of racing resembles Tour de Sol racing in some aspects. It requires solar power, it covers a span of many days, it is run on public roads, and it travels cross-country from start to finish rather than in a loop. However, the scale—and challenge—is larger. Rather than a few hundred miles, the competitors must travel more than a thousand miles. And while solar energy is only auxiliary on many Tour de Sol cars, it is the sole source of motive power for a transcontinental racer.

The Great Race

The challenge in 1987 was awesome. Competitors had to cross the continent of Australia—1900 miles, from Darwin in the north to Adelaide in the south—powered solely (Sol-ly?) by the sun. In order to do this, the cars had to be as light as possible, with as large a solar area as the rules allowed, and as aerodynamic a shape as possible. These three constraints pulled in different directions. To optimize any one meant skimping on one or both of the others.

In addition, the car had to survive the baking heat of the outback. It also had to be stable in the natural winds of "willy-willys" (sudden strong whirlwinds) and in the unnatural winds of passing "road trains" (fast-moving semi tractors pulling a string of three cargo trailers).

Twenty-three teams gathered for the race. Some were corporate, some were school teams, and some were private. The sophistication of their technology covered a wide range, depending on budget. All had to demonstrate a minimum level of roadworthiness to compete.

It was no great surprise when the GM "Sunraycer" won the race handily. It was rumored to cost $11 million dollars, $8 million for the gallium arsenide satellite-grade solar cells alone. It had silver zinc batteries and a co-efficient of drag of 0.12. It proved that nothing beats cubic money.

However, it also whetted an appetite among the competitors. Once was just not enough. Transcontinental solar racing was established.

Australian Rules

The World Solar Challenge was repeated in 1990,

1993, and 1996, always in Australia. The race has now been bought by Australian Major Events, a South Australian government agency, and it has become a biennial event. The next one will be Oct. 18–27, 1998.

The basic premise is simple. The cars come to the race with batteries fully charged from any source of power. After the race starts, however, only solar charging is allowed. The first car over the finish line wins the World Solar Challenge Cup, and separate prizes are awarded in different classes. Any car that does not reach the finish within five days after the leader is considered a non-finisher.

Details, Details

Of course, it's a little more involved than that. A maximum of seventy vehicles may compete. Categories include private entries and high schools, advanced education institutions, and commercial entries. These are further classified by solar cell type, battery chemistry type, and single or double seating.

The racing day begins at 8:00 am. The cars do a mass grid start, with position determined by results from the qualifying and handling trials. Racers must stop promptly at 5:00 pm, wherever they are, and make camp.

Every minute the car runs after 5:00 causes one minute of delay on their starting time the next day. Every minute after 5:40 causes two minutes of delay the next day.

Stationary charging is allowed for two hours before and after racing time. After the evening charge, the panels must be covered until the next morning's charge time.

Above: Massachusetts Institute of Technology's *Manta* at the starting line. MIT was the winner of Sunrayce '95.

As in Tour de Sol racing, all normal traffic laws must be obeyed, in addition to race rules. An observer rides in the chase vehicle behind each racer to verify compliance. The car cannot be pushed or pulled, except to get it safely off the road in cases of breakdown. No drafting of lead vehicles is allowed, nor "bow wave" pushing by the chase vehicle.

There are periodic mandatory 30 minute stops along the route. These serve as checkpoints as well as media opportunity spots.

Technicalities

The solar array must fit into a box 4.44 meters long by 2 meters wide by 1.6 meters high, and length multiplied

Below: At the finish line of the 1996 World Solar Challenge.

Transcontinental Solar Racer Typical Specifications

Car Type	Purpose Built, Closed Wheel
Design Constraints	Open Design With Limits on Size of Car & Solar Array (Sunrayce Only: Limits on Type of Solar Cells & Batteries)
Weight	750 - 1100 lbs.
Voltage	80 - 110 volts
Racing Speed	25–35 mph
Course Type	Street (Town & Rural Public Roads)
Course Length	1800–1900 miles
Start Type	Standing, World Solar Challenge: Mass Grid, Sunrayce: 60 Second Intervals
Duration	Enduro (9 Days)
Field Size on Course	40–70
Winning Criteria	Speed (Over Full Distance)
Sanctioning Body(ies)	Sunrayce in USA, World Solar Challenge in Australia, & Int'l SolarCar Federation

by width cannot exceed 8 square meters total. Two-seat vehicles (which must carry two people) are allowed 6 meters in length. The entire car cannot exceed 2 meters wide by 1.6 meters high by 6 meters long.

Batteries can be replaced during the race, but only with severe time penalties. They can only be replaced for reasons of accident or malfunction, and must be replaced by the same model and quantity of batteries.

Battery pack weight limits vary with chemistry type. The overall pack is limited to 5 kWh of capacity, measured at a 20 hour rate. Using this yardstick, weight limits are assigned based on battery type.

There are weight minimums on drivers. Drivers weighing less than 80 kg must carry ballast. Heavier drivers, however, do not receive any credits. Since the cockpits are small, drivers tend to be small as well. Each car is also required to carry one liter of drinking water for each occupant.

Below: Long, lonely stretches of the Australian outback.

Like the Tour de Sol, this is not a high speed event. The average speed of racers is below 40 mph. However, they must average 24.85 mph (40 kph) to be allowed in the race, and to be classified a finisher.

Born In The USA

A second race in the US fills in the alternate years between Australian races. This is the Sunrayce, sponsored by General Motors, Electronic Data Systems, and the Department of Energy. It is restricted to colleges, universities, and other higher education institutions. Each time, a different cross-country route is chosen. This year, the Sunrayce runs from Indianapolis to Colorado Springs between June 19 and June 28.

The first Sunrayce, in July of 1990, pitted 32 team against each other over 1800 miles, from Florida to Michigan. The top three finishers won a trip to Australia in November to compete in the race there. Now there are up to seventy teams competing in regional qualifying events on closed tracks. Only forty are chosen for the race.

Rules are very similar to the World Solar Challenge. The cars start with fully charged battery packs, but for the duration of the race they can only charge from the sun. All traffic laws apply, and no pushing, pulling, or drafting is allowed.

At the end of ten days, the car that covered the course with the least elapsed time is the winner.

Here's The Plan

The racing day begins at 10:00 am. Cars are assigned starting times at 60 second intervals, with position based on their current standing. Each car has 8 1/2 hours from its starting time to finish that day's leg.

If the car cannot finish the leg in the time allotted, it must still stop promptly at quitting time. It is then

trailered to the finish point of the leg, and its elapsed time is adjusted by a formula based on how far it had to be trailered.

Stationary charging is allowed from 6:00 am to 10:00 am, and from whenever they cross the finish line until 9:00 pm. After that, the cars are impounded and unable to charge until morning.

Speeds are similar to World Solar Challenge speeds, although one team did manage to average 50 mph for one 165 mile leg.

There are carefully controlled 15 minute pitstops. During this time, the timeclock is stopped, and crews can do minor maintenance and repairs, and charge their batteries from their solar arrays. The main purpose of the stop, however, is public education and media exposure for the cars. After the fourth day, competitors may take one day to rest and recharge, using solar power only.

Hardware Nitty Gritty

The solar array must be rigidly fixed to the chassis, and must fit into a box 5 meters long by 2 meters wide by 1.6 meters high, while the entire car can only exceed this size by one meter in length. Also, in racing configuration, the array must be parallel to the ground in length and width. For stationary charging, the angle can be changed, but not the shape.

In an effort to create the proverbial level playing field, the solar cells must be made in America and available to all the teams, and must not exceed $10/watt. (No gallium arsenide here.)

In the beginning, many teams used silver zinc and other exotic batteries. That has changed. Now the batteries must be rechargeable commercially produced lead acid batteries. They cannot be modified in any way, including additives to the electrolyte. There is no limit on number of batteries or pack voltage. However, the entire pack cannot weigh more than 140 kg.

Although batteries can be replaced during the race, it must be a one-for-one replacement of the same model of battery, and there are penalty points for replacements. Batteries must be inspected and marked with an official seal.

Drivers are ballasted to 80 kg, just like the World Solar Challenge drivers. The driver's position is carefully specified. The driver cannot travel headfirst, and the driver's head must be higher than his or her legs; in other words, a slightly reclining position is standard.

The cars almost universally use brushless DC drive systems. This type of system is very efficient in an ultra-light vehicle that travels at steady speeds.

Above: The GM *Sunraycer,* winner of the first Australian race.

Placing a dollar value on such a car is difficult. They may range from $30,000 to $250,000 in components. However, approximately 80% of this value comes to the teams in the form of hardware donations from manufacturers. There is very little cash that actually passes through their hands. Corporate entries in the World Solar Challenge, on the other hand, can run into millions of dollars.

Pushing The Solar Envelope

Unlike rally and tour cars, there is little practical about solar racers. They are cramped, expensive, fragile, and slow. However, they aren't meant to be practical. They are a testbed and proving ground for technology, a training camp for tomorrow's engineers, and they carry the banner of solar energy for the world to see.

Access

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EV Tech Talk

Mike Brown

"How can I build a low-cost, low-performance EV? I don't really need anything more."

Since I started writing this column, this is one of the most frequent questions I get. I think I'll address the two criteria for this EV separately, starting with the low performance aspect first.

The common statement I hear is, "I live ten miles from work with a route that uses surface streets only with no hills. Why do I need a full-sized high voltage (96 to 120 Volt) conversion with a 60 mile range and a 70 mph top speed?"

The quick easy answer, at first glance, is that a low voltage (48 to 72 Volt) EV should work. However, a close examination of this concept reveals some problems. Is the EV going to be a conversion of an existing steel bodied sub-compact car? If this is the case, the 72 Volt system is the minimum option, and it is marginal.

The reason is that, in an EV, the speed the motor runs at (and therefore the speed at which the car goes down the road) depends on the battery pack voltage. The lower the voltage, the lower the speed. "Fine," you say. "I'll drive the car in a high gear to get the speed I need to stay with traffic."

Yes, that is a solution. But while using a high gear may multiply the motor speed to a higher speed at the wheels, the same gears reduce the amount of torque to the wheels. Thus, you must use more torque to move the car at the desired speed.

In an EV, the amount of torque produced depends on the amps sent to the motor by the batteries, through the controller. The more torque required, the higher the amp draw from the batteries, and the shorter the range of the EV.

The higher amp draw may also require a bigger, more expensive controller with a higher continuous duty rating. A VW Rabbit converted to run on 72 Volts would weigh 2500 lbs., go about 45 mph top speed, with a range of about 40 miles. Yes, you can get the weight down even lower with 12 Volt batteries, but their lower capacity would further reduce your range.

For comparison, the 2880 lb. 96 Volt Voltsrabbit that I drive has a range of 80 miles and a top speed 65 mph on the flat. It has a 42 mile range even when I have to climb 1400 feet up a mountain to get to where I live above Santa Cruz. The extra Volts make all the difference.

But you say low performance is all you need. Let's examine that statement. Does it mean you can live with a car that can never go on the freeway or expressways? Is a maximum 40 mile range enough? Do you have another car for all the rest of the driving you do beyond a 20 mile one way trip? What happens in the winter if you live in a cold winter climate and the battery capacity falls from 85% at 50 degrees to 55% at 0 degrees?

As for the low cost aspect of such a EV, not having to buy four batteries and using slightly cheaper components only saves you about $900.00. The time it would take to design and build such a conversion would be the same as a higher voltage conversion.

I have always said that an EV is a mission specific vehicle. If your mission for the EV is not affected by the above limitations, and the dollar savings help make it possible, then build it. Just be sure, before you invest the time and money, that the resulting vehicle will really satisfy your needs. If I can help you get an EV on the road, call or write or email me and I'll do what I can. I just want to be sure you won't be disappointed.

"Okay," you say, "skip the steel-bodied conversion. I'll build a two seat, light weight, purpose built car that will require less Volts and Amps to run." In the early 1970s the Sebring Vanguard company built a purpose built EV called the CitiCar. This car was a 1475 lb. 48 Volt purpose built EV, and the company literature listed its range at "up to 40 miles" and its top speed as "35 to 42 mph". This performance was just about right considering the batteries available at that time, as well as the low-tech resistance and series-parallel speed control system used. It also suited the marginal braking and handling characteristics of the chassis.

There have been a couple of "neighborhood car" EVs introduced in the past year but the price tags indicate that it has to be a rich neighborhood. There has also been talk of licensing golf carts to run on surface streets. I feel that the cost of bringing them up to minimal safety standards (adding running lights, turn signals, brake lights, horn etc.) coupled with their dangerously low speeds don't make them a viable option.

Since an overwhelming amount of my mail is showing an interest in this type of EV, with very few suitable

vehicles available, maybe it is time for Home Power readers to start a design forum and come up with an affordable, home buildable, personal EV.

I am willing to use this column as a clearinghouse for this type of discussion. The first part of this project is to define the market for the vehicle. If you would be interested in a low voltage, low performance EV, contact me. Tell me what you want and need—top speed, range, driving conditions, passenger and cargo capacity, and so forth. Let's see if we can develop a consensus.

The second part is designing the vehicle. We don't need to invent a new drive system. There are perfectly good smaller versions of the components we are already using in conversions—motors, controllers, chargers, etc. What we need to develop is a suitable light weight chassis to put them in.

I think we should limit our discussion to three-wheeled designs, because this gets us around a whole lot of regulatory red tape. We should also concentrate on low cost materials and techniques. Remember, low cost is one of the main reasons people want a low performance EV, so no carbon fiber or exotic technologies. Two seats are probably recommended. So, where do we go from there?

I will talk with people who contact me, and from time to time use this column to publish some of the ideas. Let's see what we can come up with.

Access

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Direct Access in '98

Don Loweburg

Based on an updated California Public Utilities Commission ruling released in May 97, direct access for all customer classes in the state will become effective January 1, 1998. Previously I had reported that direct access would be phased in over a four year period. Now residential customers will also be able to choose power providers next year.

Probably individual customers still won't gain much. But by aggregating, apartments, neighborhoods, and even cities, customers will be able to bargain collectively for power. If the surveys showing citizen preference for renewables are correct, this will mark the beginning of a new era for renewables as customers begin choosing renewable energy suppliers.

Citizen Power

Tim Willhelm, owner of Willhelm Engineering (renewable energy systems), is working with Illinois State Representative Mary K. O'Brien to get a net metering bill before the Illinois State Legislature. Readers in that state please contact Tim and pitch in (see access).

Tim lives in the small community of Stelle, Illinois. The community of 150 people and about 50 homes has the nation's first PV powered telephone exchange using a 2 kW array. They also have a 10 kW Bergy wind turbine powering the municipal water system. This case illustrates the fact that renewable energy is a bottoms up technology. Individuals and communities will choose renewables to meet their needs and support their values. Tim commented that the local utility created many headaches for the project.

Symposium in Santa Barbara, California

Titled, Critical Issues in America Symposium–U.S. Solar and Renewable Energy Policy, this one day meeting took place this May at the UC, Santa Barbara campus. The organizer, Global Possibilities of Santa Monica, CA, invited individuals representing a wide spectrum of positions, roles, and opinions. The format was a round table discussion within an informal atmosphere. The following is nowhere near a complete chronicle of the meeting, but rather represents comments and points that stuck in my mind.

Hunter Lovins of Rocky Mountain Institute shared some of her experiences working with corporate executives and their experiences of epiphany. Sudden insight and transformation resulted in massive organizational changes within the companies they controlled. For her, change from the top down based on a change of heart of leadership, is a very real possibility.

Ed Maschke of California Public Interest Research Group (CALPIRG) commented on the inequity of the Competitive Transition Charge (CTC). His conclusion was that the average residential consumer of electricity will be worse off after restructuring. He also noted that the effect of restructuring may be a gutting of environmental and renewable energy programs in the state.

Michal Moore of the California Energy Commission stated that "restructuring" was really more like "re-regulating" and that now there are ten utility commissioners in the state of California, five at the CPUC and five at CEC. He stressed the difficulty of working with and balancing the enormously powerful forces that bear on him as a commissioner.

Dan Berman, co-author of *Who Owns the Sun*, emphasized the need for political democracy in energy matters and pointed out that the most successful PV program in the country was the product of a municipal utility under the control of a locally elected board. Steven Strong of Solar Design Associates stressed the need for an amplified interconnection standard. This standard would be determined and enforced by agencies independent of the utilities (local building inspectors?).

Amory Lovins of Rocky Mountain Institute discussed the super light "hypercar"(a fuel-electric hybrid) being developed and promoted by RMI. He also talked about distributed generation and the many economic and environmental benefits that make this new energy paradigm a model for the future. He stressed that it really doesn't matter what regulators do. The transformative power of new technology and markets will shape the industry. He referred to the "withering away" of the utilities to be replaced by what he calls the "distributed utility". Christopher Flavin of Worldwatch Institute also focussed on technology. He outlined how large corporations are shifting their attitudes about renewables and energy efficiency. Recognizing value in these areas is being translated into improved competitiveness. Ed Begley, actor and activist, stressed personal action as an important tool of transformation. By driving an electric vehicle and living in an off-grid solar home, he makes the tangible benefits of renewables visible. "Lead by example," was Ed's message.

I made the point, on behalf of IPP, that the new energy markets being opened up by restructuring and the shift to distributed generation created tremendous opportunities for renewable energy companies. These are clearly competitive markets and should not be open to regulated utilities (Remember, they are supposed to be getting out of generation as part of restructuring–See section further on) It is our belief that implementation of this one policy will do more for renewable industries than all the subsidies and possible punitive carbon tax policies combined.

In summary, this meeting provided a smorgasbord of viewpoints. I suspect that few positions were changed. The exchanges were congenial. The food was good. To quote an illustrious attendee, "Big dogs eat first".

Sustainable Energy Coalition Updates
Available by fax, this very informative listing of breaking information is updated weekly. Included are listings of events, legislative actions, restructuring information and all kinds of renewable energy news. If you are a renewables activist or want to be, contact Ken Bossong. (see access)

National PV Interconnection Standard
Last issue I mentioned that John Stevens of Sandia Labs was leading a group working on creating a national interconnection standard. He sent me a draft copy (IEEE P929) of the proposed standard. I would like to share my comments and his reply

I just received the latest Sandia newsletter (Volume 2) covering interconnection issues. Your perspective and suggestions are very welcome and constructive. I see one major problem being the extreme variability among the utilities. They are all over the map in terms of what they want and think is important. I'm faxing you part of (Southern California) Edison's newly revised tariff and interconnection agreement for net metered, under 10 kW residential systems. It's simple and relies on NEC 690 and UL. This is what I'd like to see for all utilities. I would go one step further. Have the interconnection (for small, 10 kW or less, residential systems) inspected by local jurisdictions (building inspectors) using NEC 690, incorporating UL testing and IEEE criteria. This is the way it's done for everything else in the building industry. The utility would simply be notified of the system's location. The standard disconnect means should utilize a dedicated and labeled inverter disconnect breaker in the main panel. Keep in mind that the main service disconnect (house main breaker) provides yet another level of disconnect redundancy (in addition to the inverter's automatic protection). This is per current NEC 690 specs. The need for islanding (Islanding is a situation that may occur when the grid looses power but two or more local generating sources remain active. In effect, each inverter sees the others as the grid and thus does not automatically shut down.) mitigation and automatic inverter shut down is clear. Yet some engineers are approaching this from the wrong direction—concocting the worst case–most improbable scenario and then requiring a general standard to conform to it. It would be better to base the standard on the most probable situation. Additional language could be included that allows special requirements for special situations such as PV subdivisions or other high penetration areas. Again, I'm concerned with the small residential installation and not QFs (larger commercial facilities). Many utilities fail to perceive or make distinctions between these radically different kinds of installations.

Safety is paramount and that is why standard operating procedure always includes testing and grounding any line before commencing work (this is universal with every lineman I have talked to) This procedure in conjunction with the standards already proscribed (NEC 690) (and updated by your group) make small PV systems under 10 kW installed according to the Simplified Net Metering Interconnection standard (Edison's as an example) as safe as is humanly possible.

Reflect on this. Every winter tens of thousands, maybe hundreds of thousands of small gasoline generators are "back fed" into residential systems for backup during power outages. These setups have no automatic shut down, no transfer switch, and no way of knowing if even the main disconnect is used to isolate the source from the grid. Without having exact facts, I surmise that this practice must lead to some level of injury far in excess of any caused by modern inverters. Yet it seems that the PV-Inverter industry is being punished while trying to do the right thing.

The utilities prefer to ignore the widespread notorious misuse of gasoline generators. Is this what they wish for inverters? It is human nature to side step rules and regulations, especially if they are perceived as cumbersome, burdensome and arcane. With the proliferation of grid connectable (synchronizing) inverters readily available off the shelf (especially the new lines of AC module-inverters), citizens can do whatever they want! By having a Simplified Net Metering Interconnection standard, safe interconnection practices can be fostered rather than ignored.

John replies:
Thanks for your thoughtful comments. I'd like to stress one thing (a thing which makes this IEEE standards writing process particularly painful). Adoption of IEEE standards by utilities is purely voluntary. In other words, if we write the most wonderful standard in the world (from the PV community perspective), but it doesn't adhere to standard utility practices, then the majority of utilities simply won't adopt it. What we're hoping for is that the combination of a utility-friendly standard and the UL test procedure will provide a standard that is "irresistible" to utilities. I agree with your observation that human nature is to accomplish what one feels is necessary, and that obstacles thrown in the path are simply ignored, such as the case with interconnecting engine/generators without even telling the utility anything about it. Again, we'd like the process to be simple from the user's side, too. Essentially, as you mention, buy a UL-listed inverter and install it in accordance with the NEC and your utility will accept it. There are an awful lot of details between here and there that need to be worked out, but we've got a great group working on this project from both the utility and the PV side, and I have confidence that we'll eventually end up with a standard that both communities will be happy to adopt. The disconnect switch is one such detail that may not go away. It turns out that the National Electrical Safety Code (a different organization than the one which publishes the NEC) requires such a switch in order to comply with Section 444.C. I'm not sure we can have a majority of utilities accept our standard if we ignore something required by the NESC. (I'm not sure the IEEE will approve a standard that doesn't comply with the NESC, as it is also an IEEE standard.) We're still working this issue. Thanks again for your comments.

Perhaps we need a national "universal grid access" law that is not voluntary on the part of the utilities?

National Net Metering Law
One of the lessons learned implementing a net metering law in California was that each utility has their own, often capricious, interconnection requirements. Nationally the

standards are also enormously variable. What has become clear is that in addition to net metering, the law must also include uniform interconnection standards. Rather than writing one for each state, a national net metering law is needed that includes the interconnection requirements in the law!.

Tom Starrs, Ph.D. in Energy & Resources from UC Berkeley, and a consultant specializing in the design and implementation of energy policy initiatives on behalf of renewables energy technologies, shares the following.

“The proposed national net metering legislation that I drafted for SEIA includes the following language, which was borrowed from the most recent model state net metering bill:

(a) Solar electric equipment used by solar electric customer-generators shall meet all applicable safety and power quality standards established by the National Electrical Code, Institute of Electrical and Electronics Engineers (IEEE), and accredited testing laboratories such as Underwriters Laboratories.

(b) Solar electric customer-generators whose solar electric equipment meets the standards of subsection (a) shall not be required to meet any additional standards, perform any additional tests, or meet any additional requirements arising from their status as solar electric customer-generators’.

“This sounds like what you’re suggesting. I couldn’t agree with you more about the need for uniform standards. I would be happy to write something up for the IPP newsletter, or contribute a quote or two. My basic pitch is this: Utilities have a legitimate role to play in protecting and maintaining the safety and integrity of the grid. However, there is a conflict of interest in having utilities determining the terms and conditions of interconnection for residential PV systems which, after all, are competing with utility generation (and other non-utility generation that the utility makes money from through T&D fees). The obvious answer is to have uniform, national standards set by the relevant bodies—NEC, IEEE, UL/ETL—and to have the utilities address their legitimate needs by participating in the process of setting those standards. If a utility thinks every grid-connected PV system should have an isolation transformer, then it should have to make the case to one of the national standard setting bodies on a cost-benefit basis—rather than imposing it willy-nilly without any opportunity for review and/or challenge. Meanwhile, regulators have a very, very important role to play in this process by monitoring the interconnection requirements imposed by utilities and ensuring that they are reasonable and cost-justified. Otherwise the utilities may be engaging in a so-called ‘exclusionary practice’ that is intended to—and has the effect of—using the utilities’ monopolistic control of the grid to unfair competitive advantage.

This is an issue not only for PV but for other potential distributed generation technologies that will want to have access to the grid, including fuel cells, micro-cogeneration units, and micro-combustion turbines. Advocates of these technologies also should have an interest in this issue.”

Issues of Monopolistic Control Extend to DG

Tom continues, commenting on points raised in last issue’s (HP 59) column about regulated utilities pursuing Distributed Generation (DG).

“The issue of utility involvement in DG is a little trickier, but the basic principle is the same: Utilities should not be able to use their control over network facilities (including interconnection) to favor their own investments over competing investments. If they conclude that DG is needed/economically viable to provide grid-support at a certain location, they should bid it. Their own unregulated subsidiaries should be welcome to bid—as long as the structural and/or accounting separations are in place to ensure that the utility doesn’t unfairly favor its own sub over the competitors.”

Notice that only the unregulated subsidiaries can bid in Tom’s view. The regulated utility is excluded. IPP takes a stronger view. We think the unregulated subsidiaries should also be excluded from bidding in the regulated parent company’s territory. The reason for the stronger position is that it is too difficult to insure that the accounting and structural separations that Tom mentions are in place and enforced.

News Clips—Hint of things to come?

Reminiscent of the turmoil and activism that was generated during the construction of nuclear power plants 25 years ago, public outrage at the “transition” charges being levied to recover their “stranded cost” is boiling over.

(5/28/97) “PECO PROTESTERS ARRESTED AT STORMY PA. UTILITY COMMISSION MEETING: The state Public Utility Commission—in a stormy meeting marked by the arrest of five protesters yesterday voted to allow PECO Energy Co. of Philadelphia to refinance and pass on to customers $1.1 billion of the $6.8 billion in stranded costs it says it will have in a competitive energy market. (Knight-Ridder)” Much more on this next issue.

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Flex is Out and the Dodo Diode Isn't Dead

John Wiles

Sponsored By The Photovoltaic Systems Assistance Center
Sandia National Laboratories

The news is not good, but please don't shoot the messenger. First, an electrical inspector has pointed out that the very popular flexible non-metallic conduit should not be used with PV modules. Second, although some system designers have said that the blocking diode is as dead as the extinct Dodo bird, there may be good reasons for using diodes or fuses in all systems.

Flexible Conduit

Liquidtight flexible nonmetallic conduit as described in Section B of Article 351 of the National Electrical Code (NEC) is often used for containing the wiring from PV modules to nearby junction boxes. This flexible, light-weight, gray plastic conduit is widely available in building supply stores and electrical supply houses in both precut and bulk lengths. The conduit cuts easily with a knife and the termination fittings are easy to install.

Unfortunately, this type of conduit is listed by Underwriters Laboratories (UL) for use at 70 or 80°C when dry and only 60°C when wet. NEC Section 351-23 (b) (2) states that this conduit may not be used where any combination of ambient temperatures and conductor temperatures are in excess of that for which the conduit is approved.

Conduit attached to PV modules is in an exposed location and wet-rated conductors must be used in all conduit that is exposed-see Definitions (location) in the NEC and NEC Handbook. Most PV modules are listed for use with 90°C conductors because junction-box and back-of-module temperatures can exceed 70°C. For these reasons, the conductors used in the installation of PV modules must have a 90°C insulation rating when wet. Typical cables are THWN-2, RHW-2, and XHHW-2 all having a 90°C insulation rating.

With 90°C cables, high ambient temperatures (70°C+), and possible wet conditions, the NEC says that the liquidtight flexible nonmetallic conduit marked 70°C dry/60°C wet cannot be used. UL is considering revisions to UL Standard 1703 that might require that either the listed PV module or the instructions for the listed module state that the use of this conduit is unacceptable. The flexible nonmetallic conduit can deform at high temperatures and reduce the internal area (needed to maintain the ampacity of the conductor), or the deformation and water can cause the fitting on the end of the conduit to come loose from the conduit.

Alternatives that can be used for PV module connections include liquidtight flexible metal conduit, ridged nonmetallic conduit (PVC), and several of the metal conduits. In addition, where conduit is not needed, outdoor-rated, exposed (not in conduit) single-conductor cables may be used. While these alternatives are, in some cases, more expensive or more difficult to use, they will ensure that the cables are adequately protected and that the protection will not fail due to high temperatures or wet conditions.

The Dodo Diode and The Series Fuse

Each PV module listed to UL Standard 1703 by a recognized testing laboratory is marked with the maximum current value of a series fuse intended to protect the module from overcurrents that may be forced through the module under fault conditions. The NEC requires that all instructions and labeling provided with listed modules be followed. This fuse requirement is in addition to other NEC system requirements to provide proper overcurrent protection for all conductors.

As PV system designs have matured over the last ten years, there has been a divergence of the design and installation practices between high-voltage (over 50-volts) and low-voltage systems. High-voltage systems, usually utility-interactive, have always employed blocking diodes and overcurrent protection for each string of series-connected modules. This NEC-required overcurrent device usually has been sized to provide overcurrent protection for the conductors in the series string and has been generally near the value of the required series fuse (required by UL Standard 1703) used to protect the PV module.

In low-voltage systems, system designers have been very concerned with power losses and voltage drops in these mostly stand-alone, battery-charging systems. Blocking diodes went the way of the dodo bird as designers found that the daytime losses through the diode exceeded the very low losses associated with

night-time reverse current flow through the modules when the diode was removed. Many of these systems, but not all, have charge controllers without blocking diodes that disconnect the battery at night. There are many systems that do not employ charge controllers at all. Other charge controllers respond only to battery voltage and do not prevent reverse current flow from the batteries into the modules. Although overcurrent protection is usually provided for the conductors in the system, the rating of these overcurrent devices may be many times the value needed for the PV module protective fuse. Typical conductors used for module and array wiring have an ampacity several times that required by the individual module or module strings, and the overcurrent device is rated at these higher values to protect the conductors from backfeed currents from the batteries. Thus, in common practice, when a module fuse or blocking diode is not used, the module has insufficient overcurrent protection. On typical 12 and 24-volt systems, as much as 1000 watts of PV modules may be connected to a single source circuit without blocking diodes or module overcurrent protection.

Simulations

Simulations were run by David King at Sandia National Laboratories. The simulated 36-cell PV modules were equipped with bypass diodes around every 18 cells, but no blocking diode or series fuse. Two modules were connected in series to charge a simulated 24-volt battery. Various fault conditions were simulated.

First, a ground fault was simulated in the wiring between the PV modules. The battery voltage forced a reverse current of 7.5A through the first module, dissipating 198W in the module. The result was dynamic where the module heated up, its resistance to current flow decreased, the reverse current increased, and power dissipation increased until thermal equilibrium or an open circuit occurred. At 60°C module temperature, the simulated reverse current was 10.8A (285W). If a single string of 18 cells remained in the circuit, as might happen if a ground fault occurred at a bypass diode termination in the module junction box, over 50A of reverse current passed through the cells and 1350W were dissipated. A ground fault internal to the module (cell interconnect to frame or other grounded surface) was simulated leaving a single cell in the circuit. This case would be catastrophic with hundreds of amps of reverse current flowing through the single cell. In each of these cases, the simulated fault current from the battery would have been high enough to cause damage to the PV module. These simulated failure modes were verified with tests on PV modules and PV cells.

Test Results

A typical 40-watt, 33-cell, glass/Tedlar, 12-volt PV module was tested in a manner that might duplicate the conditions created by a ground fault in the series interconnecting cable between two such modules in a 24-volt PV system. This conceptual PV system had a number of parallel module strings and/or a battery bank capable of back feeding the array. A PV-charged battery bank at 26.5 volts was connected to the test module-positive-to-positive and negative-to-negative. Initial reverse current flow was 18.5A (490W). The module was shaded. Over the next 45 minutes, the cell temperatures went from 28°C to well over 200°C as the current increased to 39A (1034W). Bubbling of the encapsulant and some smoke were noted around the cells backed by the junction boxes (less heat radiation to the rear of the module in these areas). The Tedlar backing delaminated in a non-uniform manner from the rear of the module in areas where the cell temperatures were the highest. Forty-six minutes into the test, the PV module developed an open circuit, probably due to solder bond failures on the cells in front of the junction boxes. Although no flames were evident, the Tedlar was significantly discolored and the module was damaged beyond repair.

To evaluate a more severe situation, a similar test was conducted on a series string of nine silicon PV cells where the negative connection of the laminated string was connected to battery ground simulating a ground fault that could occur in an aluminum-backed module or a thin-film module laminated to a steel roofing panel. In this situation, the battery voltage (26.5V) was applied across the cell string. The reverse currents of more than 100 amps quickly caused the string of cells to develop an open circuit as the internal solder bonds melted. Tests on strings of 18 cells in series also resulted in open-circuited modules.

In no case was fire evident, but module temperatures in these tests were over 200°C (392°F) which could possibility start fires in dried leaves, grass, or even bird nests behind modules.

Solutions

Wiring the PV array to the requirements of the NEC with the correct size cable and the proper overcurrent protection for that cable will help to reduce the magnitude of the problem. Such wiring will limit the magnitude of potential backfeed current from parallel strings of modules or from the battery. Even with NEC-compliant wiring and overcurrent protection, the backfeed currents described above are sufficient to damage PV modules. Adherence to the markings on listed for a series fuse for each module or string of modules is necessary to provide full protection.

Fuses, while meeting all NEC and UL requirements, can present problems. Numerous fuses (one per module in 12-volt systems) installed in 12, 24, and 48-volt systems may pose significant operational and maintenance

(O&M) costs to the PV system. A few out-of-sight-out-of-mind, failed fuses installed in PV module junction boxes may never be replaced until the system fails entirely.

Although blocking diodes are not tested or listed as overcurrent devices, they do, in fact, prevent reverse currents from flowing. While diodes can fail in a short-circuited manner, they may prove to be more reliable than fuses in this application. Diodes, if considered by a modified UL Standard 1703 and the NEC as a required integral part of the PV module, could be the solution to this problem. Diode losses in low-voltage, battery-charging systems would have to be addressed. A modification to UL-1703 could require that blocking diodes be installed in each PV junction box on 12-volt systems and in one junction box per module string on higher voltage systems. Equivalent protection provided by fuses or other means could also be allowed.

It is suggested that blocking diodes or series fuses be installed on all systems. In a 12-volt system, each module needs a blocking diode or fuse. On 24 and higher voltage systems, each series string of modules needs a diode or fuse. The diode should have a current rating at least 1.56 times the short-circuit current rating of the module or string of modules. Electronic parts suppliers can supply silicon power diodes at low cost. At least a 400-volt diode should be used on a low-voltage PV system to provide some degree of surge protection. For example, Digi-Key Corporation (800-344-4539) has 6-amp, 400-volt diodes available at about $6.50 for 10 diodes (part # GI754CT-ND). The diode or fuse should be installed in series with the positive output of the module or string of modules. The band on the diode should point toward the positive battery terminal. The diode can usually be installed in the module junction box using the spare terminal (if any) provided.

DC rated, UL-listed fuses such as the Littelfuse KLK-D are available that are rated at 600 volts and various current levels. They are about $6-7 each and require a fuse holder. They are probably too large to mount in a module junction box. They do not, however, have the voltage drop and power loss associated with the blocking diode. Type ABC fuses from Bussmann may be a little cheaper and also have a DC rating. Fuses can be ordered from the larger electronic supply houses like Digi Key, Newark, and Allied. The ampere rating of the fuse should match the fuse size marked on the back of listed modules. If the modules are not listed and have no marking suggesting the proper fuse size, then the fuse size should have an ampere rating of about 1.56 times the module short-circuit current.

Your Failed Modules

It is suspected that ground faults described above may be more common than previously realized. These faults may have caused modules to fail for no apparent reason. The Southwest Technology Development Institute and Sandia National Laboratories are interested in examining failed modules that may have failed for the reasons described below. Anyone having modules that have failed for unknown reasons should contact me at the address below. Please be prepared to provide a description of the system where the modules were installed and the type of module including all information from the back of the modules and the stamped production date code. If the modules are types that are of interest, we may be able to provide a limited number of new modules at no cost in exchange for the failed modules.

Conclusions

It is evident from the simulations and actual tests that PV systems without protective module fuses or blocking diodes on each module or string of modules can be subject to extensive damage in ground-fault situations. Systems that have the capability to generate reverse currents in excess of the values indicated by the required protective fuse on a PV module can cause damage to the PV modules and may cause fires. PV systems that are ungrounded or systems that have insufficient sources of current would not be subject to this problem. The installation of fuses and/or blocking diodes in each module (12-volt system) or string of modules (24-volt and higher systems) appears to be the only solution to this serious problem.

Questions or Comments?

If you have questions about the NEC or the implementation of PV systems following the requirements of the NEC, feel free to call, fax, email, or write me at the location below. Sandia National Laboratories sponsors my activities in this area as a support function to the PV Industry. This work was supported by the United States Department of Energy under Contract DE-AC04-94AL8500. Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy.

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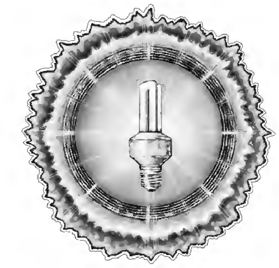
 The 1996 NEC and the NEC Handbook are available from the NFPA • 1 Batterymarch Park, Quincy, MA 02269-9101 • 800 344-3555 • 617-770-3000.

Home Power's Business



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Sir Thomas Lipton — 1870

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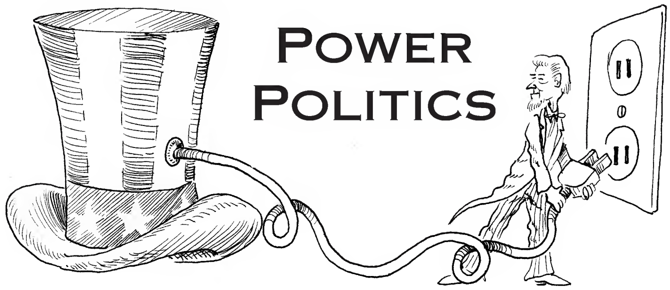

Green Electricity or Green-Washing?

Michael Welch

What should we look for when it comes to picking a green energy company to supply our electricity needs? That's an important question for grid-tied consumers to ask as utility restructuring brings new choices to the marketplace.

One of the things that utility customers have to look forward to is the opportunity to purchase electricity from "green" energy companies that promise to sell us power made with renewable energy and not made with nuclear, fossil fuel, or other polluting sources. Already some companies are positioning themselves to sell us that power. In California the first such sales will become legal January 1, 1998. Other states are preparing for the same eventuality, and some have already tried pilot programs for the marketing of both "green" sources and other sources of electricity that promise to be cheaper than nuclear. As state after state implements some form of utility restructuring and if Congress decides to act by passing a national legislation that will cover all states, the opportunity to purchase power from sources other than traditional utilities will become common.

Consumer protection is of paramount importance if we hope to make the marketing of renewable energy successful over the long term. As with any industry where large companies stand to make a lot of money, there is plenty of room for abuse.

One company moving forward with "green" energy reselling gained its fame by offering socially responsible investments and then by reselling long distance phone service "with a conscience." Working Assets (WALD, for their best known subsidiary, Working Assets Long Distance) contracted with New England Power (NEP), a subsidiary of New England Electric System (NEES), for a mix of energy that supposedly excludes nuclear, coal, and power from Hydro-Quebec (famous for its destruction of native lands for the sake of selling power to the U.S.). WALD intends to market this power to anyone interested in paying a premium price for renewable energy.

Jon Entine, a freelance writer from Ohio, has been studying and writing about green marketing and business ethics for several years. He is best known for his expose of the questionable marketing of Amazon "rainforest" products and his story "Shattered Image: Is The Body Shop Too Good to Be True?" Entine has turned his attention to companies offering green power and has been sending me and other interested parties the following information about how WALD is handling its green electricity program.

Smoke and Mirrors?

One problem is that NEES electricity contains nuclear power and power purchased from Hydro-Quebec. NEES owns stakes in Seabrook, Millstone, Yankee Rowe, and Maine Yankee nuclear power plants. NEES or its subsidiaries also acknowledge 40 Superfund toxic waste sites and 22 hazardous waste sites. All the electricity produced and distributed by NEES goes into the same distribution network (the GRID) that feeds all its customers, including WALD.

It is true that NEP produces some power from renewables and the amount of electricity that WALD purchases appears to correspond to that amount, but where should we draw the line? Any customer changing from NEP to WALD will be receiving the same energy as before, but with higher rates. Is this nothing more than an elaborate deception backed by a well-oiled marketing machine?

Laura Scher, CEO of Working Assets, states that WALD is trying to use market forces to encourage further construction of renewable energy resources as well as develop a new business enterprise. She says, "When customers buy power from Working Assets, they are changing where their money goes." WALD has been participating in "green" power pilot programs in New Hampshire and Massachusetts. Their stated purchased mix for the first quarter of 1997 averaged 51% hydro power, 41% natural gas, 3% landfill gas, and 1% oil-pumped storage. To meet New England Power Pool requirements, they also were forced to purchase about 4% "system power," all the power available to the power system operator including nuclear, coal, or Hydro-Quebec generated power.

Scher's critics believe WALD's efforts are a marketing technique, real only on paper. Even if something real was found in WALD's claims to have purchased renewables, it would mean that the WALD / NEP agreement caused the other non-WALD customers' energy mix to become dirtier than before WALD's involvement.

WALD's response to detractors is that they are giving customers the opportunity to use their dollars to tell utilities that they support renewable energy. WALD states that they hope this will eventually cause producers to increase RE resources. But is that real, or simply a justification for what Entine claims are consumer prices that are higher than any other re-marketer participating in the NEP pilot program? Entine's information says there is significant excess capacity in New England, so it would take decades before the WALD program could result in a decreased reliance on non-renewables.

Is that Cool?

As a potential purchaser of "green" power, is it OK with you if it is renewable on paper only? Is it OK that it is in a mix with other types of power? Is it OK that the utility that it is being purchased from is deeply into non-renewable and life-threatening power sources and buys power from a source that practices environmental racism? Is it OK that WALD's purchasing of NEP's power did not and will not result in a single additional electron of renewable energy? A separate question, is it OK for green power to include the burning of fossil fuel and the use of large scale hydro?

These are questions that each individual must ask themselves before acting. Some people think it's totally uncool, and that if someone is marketing "green" power, that it should come from a source that isn't into renewables just as a minor sideline. Others believe that the sale of green power should result in or come from new sources of renewable energy. I'm in the latter camp. It isn't enough just to feel good about where your own power is coming from. It is more important that what we do results in a relative increase of renewable energy resources.

Disclosure

I believe that anybody marketing green electricity should divulge to their potential customers the full details of where the power is coming from. If a re-marketer is buying shares of electricity from a utility's already existing sources, it is purchasing units of power, not power from a particular renewable source. The big promise of green electricity is to increase the amount of renewables in our nation's energy mix, and if a re-seller doesn't contract directly with renewable energy sources or invest in renewable energy itself, then there is no net positive result.

Questions should be asked of each company marketing green power to compare them to the competition. We can't make informed decisions about something so important without the relevant information. Few green energy marketers will be able to produce a "perfect" record, but these questions should be answered for a basis of comparison.

- Where does the re-marketer purchase its power?
- What is the environmental record of the re-marketer?
- What is the environmental record of the companies producing the power?
- Is the contract between the marketer and the producer for a specific RE plant or is it for a partial share of all the producer's power?
- What will be the power source during "peak" demand or other times when the green source is not enough to supply all the re-marketer's customers?
- In the case of solar or wind-produced electricity, what will be the source at night or when the wind is not blowing?
- Is the marketer investing in new wind or solar plants?
- Will the remarketer's program result in additional sources of RE electricity?

Green Power Pricing

It should be expected that prices for green electricity will be a little higher than normal. After all, it is a relatively unsubsidized industry compared to nuclear, large scale hydro, and fossil fuels. Also, there is much less of it available which could result in demand pushing it upward. But, public perception of the need for higher cost could, once again, make room for abuse. For example, of all the programs participating in the pilot program in New Hampshire, WALD's was the most expensive to the consumer.

Success in New Hampshire?

There have been recent polls cited in Home Power that state utility customers are willing to pay a little bit more for power coming from renewable energy sources. But, according to Entine's sources, WALD was only able to sign up about 75 out of the 17,000 eligible customers. This is quite scary, folks. It does not bode well for renewables if a company like WALD, with its public relations machine and large publicity budget, can't sign up more than .4%. In a Massachusetts pilot program, about 1.2% of those eligible chose supposedly green programs. In spite of polls to the contrary, the jury is still out on public willingness to support green energy programs.

Regulation Needed
How do we keep the electricity marketers honest? Unfortunately, more regulation is the answer. There are specific cases where I am a strong proponent of government regulation. It is impossible to rely on self-regulation of business when it comes to protecting the environment, human rights, worker safety, and consumer rights. And WALD is a good example. Here is a company that was founded on these mentioned principles, one that might be expected to operate far beyond the principles' bounds. Just imagine the possible abuse when huge companies like Enron get into the electricity remarketing business.

Public utility regulators across the nation are beginning to recognize this huge potential for abuse. But the energy remarketing business is so new in the U.S. that nothing is in place to protect the consumer from green washing. There has been some experience in Europe with this problem, so maybe we can look to them for consumer protection solutions.

Elsewhere
In Minnesota, Northern States Power (NSP) is gearing up to put its wind power on the secondary market. But, this project will not produce any new wind sources. In fact, NSP is required by state law to provide 425 megawatts of new wind power as part of an agreement to allow more nuke waste storage at one of its nuclear power plants. Now it hopes to market that wind power at a higher price rather than keep the wind power in its energy mix to all customers. Activists in the area are ticked off and feel that the spirit of the agreement has been violated by NSP's efforts to have the wind power marketed at higher than normal costs to the consumer.

In contrast, and in the same state, the Cooperative Power Association (CPA) plans to sell wind power to nine of CPA's 17 member co-ops. This power will come from two to three large wind machines scheduled to be built in southern Minnesota, if enough people sign up.

In California, at least one company is gearing up to market renewable energy. Clean Power Works will get its electricity from landfill gas generators, wind farms, hydroelectric generators, and/or solar energy. It will be a re-marketing of already existing facilities. Hopefully it will not be buying bulk power from polluting utilities.

There are many other companies across the nation that have been looking into the green energy market. If readers would gather as much information as possible about ones near them, I'd appreciate receiving it. As activists and consumers, we must remain vigilant against abuses of the system. Hold these companies and your utility regulators responsible for what happens to grid-centered RE. Green electricity is a great opportunity, maybe the one we've been looking for, so let's not let it get messed up.

Pledge of Support
The Center for Energy Efficiency and Renewable Technologies (CEERT) has put together a pledge for people to sign and send to their public utility commission. This pledge is meant to help get green energy a good deal in any regulatory action that a state might take. It was originally intended (and still should be used thus) to help convince the California PUC that those who buy green power instead of dirty power shouldn't have to pay the extra Competitive Transition Charge (CTC) for costs associated with paying off utilities' stranded assets (nuke plants). Anyway, please sign this statement and send it to your own public utility commission.

As a consumer concerned about the environment, I want to be able to purchase electricity from certified renewable resource providers at costs comparable to my current bills. I prefer not to send my energy dollars to polluting coal and nuclear plants any longer, even if deregulation makes dirty power somewhat cheaper.

California's CTC is an amount tacked onto everyone's utility bill to pay off utilities' poor decisions to invest in uneconomic nuke plants. Such decisions are left over from the days when utilities were guaranteed a return on their investment, no matter how expensive. Many other states are considering CTC type charges. True deregulation would have left it to competition to decide where our rate money goes, but the utilities have great influence over our regulators and legislatures and receive this bailout in spite of their stupid business decisions. Hmm, I guess they weren't really stupid. Look how rich the utilities are getting even with too-expensive nuke power and even under deregulation.

Access
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Center for Energy Efficiency and Renewable Technologies, 1100 11th St. Suite 311, Sacramento, CA 95814 • 916-442-7785 • Fax: 916-447-2940
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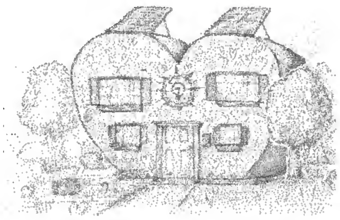
Home & Heart



Kathleen Jarschke-Schultze

Summer time and the cooking is easy. We pretty much use the microwave, solar cookers, and the gas barbeque this time of year. We stopped by Sam Erwin's workshop the other day and he gave me a new prototype of the Solar Chef to try out. Nothing (well, very few things) I like better than testing solar cookers.

New, Improved

The prototype "Chef" has increased capacity, my largest roasting pan will fit into it. I baked a fifteen pound turkey in less time than presented in my cookbook roasting chart. Granted it was only 15 minutes less time but that is still amazing.

This cooker cooks in real time. The rule of thumb has always been that it takes twice as long to cook a dish in a solar cooker as it does in a conventional oven. With the Solar Chef available now Sam has cut that time by three fourths or better depending on what you are cooking. With this new model it takes the same amount of time or less.

Design Changes

Another well thought out feature of the new Chef is that the cooking shelf remains in a fixed position and the cooking chamber moves around it. This was extremely handy when cooking that large turkey. The adjustment and focusing of the reflectors is still a one handed effortless operation.

The reflectors are made of polished metal. They radiate from the cooking chamber like the petals of a large metallic flower. On the back of each one is a bow of metal with an adjustment screw positioned two thirds of the way up the bow. This allows you to change the curve of the reflectors according to what you are cooking. If you are cooking in a pot you want the light very focused to heat the pot. If you are baking bread you would want the light more diffused so there would not be any hot spots.

A small 12 Volt fan is attached to the back wall. By connecting a small solar panel to the two connectors on the back of the oven body the cooker then becomes a convection oven also. This is especially handy when baking. That is when you want even heat all over the cooking chamber.

Portability

One of the really swell new features is that the reflectors and the ribs that hold them on come off and store (or ship) in a separate box. This breakdown will allow the Chef to shipped by carriers like UPS or Fed Ex, etc. It also allows me to break it down for easier traveling when I give a solar cooking demonstration. (Sam must have read H&H in issue #57.) All the parts that disassemble can be reassembled with nuts and bolts that only need to be finger tight. No tools required. This is so neat, I just love it.

Use and Utility

No, this isn't a newly found lost tome by Jane Austen but rather the fact that while the old Solar Chef was absolutely my most favorite solar cooker of all time the new model has stolen my heart. It does everything I need it to do. It is such a well thought out and designed unit that I simply admire it and Sam Erwin greatly.

Sam has the patent on this unit. Production is waiting for details of parting out the different components to appropriate manufacturers so that Sam's final assembly and packaging will go smoothly and efficiently. Sam has put so much time, effort, and thought into his Solar Chef that it is a work of art as much as an incredibly useful, practical appliance.

Solar Chef - Movie Star
While we were at Sam's workshop we saw the Solar Chef that he loaned to Disney to appear in their new production of "Flubber" an updated remake of the old classic. They asked him for an old Chef but there are no old Chefs in Sam's workshop so they made a new one look old. Sam has left the "makeup" on that unit and saved it for display. If you see the movie be sure to look for it.

Cleaning the Air
I was surprised that after mentioning our air cleaners in my last column I received several inquiries from readers as to make and model. Neither one is any sort of special unit. We just checked the power usage on the bottom plate of the one we bought, like we do when buying anything electrical, and it didn't seem to draw too much so we bought it.

Our first air cleaner was loaned to us by our friends, Lynne and George, several years ago and we have never returned it. We found that the house dust and ash was making Bob-O's asthma act up and our friends said that they found an air cleaner really helped at their house. It was given to them by George's parents and is an old model, probably not made any more. It is an Oster Electrostatic Precipitator. Its bottom plate says 120 vac, 60 Hz., 0.7 amps, 55 watts. After trying it we decided to get our own air cleaner and bought the other one. I guess it's time to return theirs.

The one we bought is an Enviroresearch by Windmere, model #EAC-10. We found it at a discount store on sale so we got it. I think it was around $50. The bottom plate says 120 vac, 60Hz., 1.2 amps. You can clean the filters with soap and water, except the charcoal filter which can be cleaned with a vacuum cleaner brush. The company address is: Enviroresearch, 5980 Miami Lakes Dr, Miami Lakes, FL 33014.

When we went looking for an air cleaner there were some pretty expensive models out there. We shied away from any with a HEPA filter when we found out replacement filters cost around $50. Both of our air cleaners can be cleaned with dish detergent and/or a vacuum cleaner brush. As to efficiency, after they have been running awhile, there are no dust motes in the shafts of sunlight through the living room window. That is good enough for me.

Access
Kathleen Jarschke-Schultze is going to wow the Aunties at her 21st Family Reunion with the new Solar Chef, c/o Home Power Magazine, POB 520, Ashland, OR 97520
916•475-0830
Email: kathleen.jarschke-schultze@homepower.org
or kjs@snowcrest.net

Solar Chef: 220 Southridge Way, Grants Pass, OR 97527 • 541-471-6065 or 800-378-4189

AUSTRIA

EVN Cup 1997 is Europe's largest EV race. Last year there were 500 visitors and about 80 participants. There are different races, cars, prototypes, bikes and carts. Everyone who competes the whole race independent of their results results a specified amount of money. For more info contract: Claus Drenning, via e-mail: c.drennig@magnet.at; phone/fax +43/1/714-7463

AUSTRALIA

The World Solar Challenge is now a biennial (previously every three years) event and will run October 18–27, 1998. The World Solar Cycle Challenge will run in the alternate years to create an annual focus on solar car racing in Australia. The 1997 Cycle Challenge will run September 27 to October 6, 1997. The World Solar Challenge is the premier solar car race in the world and contributes vital research and development towards the quest for sustainable future transportation. An exciting development is the introduction of an Entry Competition open to school and tertiary entrants. To ensure another great entry response from educational institution the World Solar Challenge is offering free entry to the first school and tertiary teams to register in the 1998 World Solar Challenge. For further information on entry details or regulations please contact Ray Wieland, Event Manager, level 7 178 N Terrace, Adelaide 5000, South Australia, +61 8 8303 2021, e-mail: wsc@saugov.sa.gov.au, web site: www.wsc.org.au

CANADA

The "Alberta Sustainable House" is open for public viewing every Saturday 1:00-4:00 PM free of charge. The project emphasizes cold-climate features/products based on the founding principles of occupant health, environmental foresight, resource conservation, AE, recycling, low embodied energy, self-sufficiency, and appropriate technology. Already in place: R17 windows, multi-purpose masonry heater, solar hot water, greywater heat exchangers, LED and electroluminescent lighting, solar cookers, and others. Under development: hydrogen fuel cells, Stirling co-generator, Tesla bladeless steam turbine, and others. Contact: Jorg Ostrowski, Autonomous & Sustainable Housing Inc/Alternative & Conservation Energies Inc, 9211 Scurfield Dr NW, Calgary Alberta T3L 1V9, Canada • 403-239-1882 • Fax: 403-547-2671

The Institute for Bioregional Studies was founded to demonstrate and teach recent ecologically-oriented, scientific, social and technological achievements that move us toward ecological, healthy, interdependent and self-reliant communities. For info: IBS, 449 University Ave, Charlottetown, Prince Edward Island C1A 8K3, Canada • 902-892-9578.

Electric Vehicle Society of Canada, Toronto Chapter—whose purpose is to promote EVs in order to reduce the terrible environmental impacts of conventional automobiles (and have some fun at the same time!) are a group of enthusiasts, inventors Sunday mechanics and environmentalists from every walk of life who share the belief that EVs are a viable alternative Today. Meetings are held on the 3rd Thursday of each month, September through June. New Members are always welcome! Contact: Howard Hutt, 21 Barritt Rd, Scarborough, Ontario, M1R 3S5 Canada Phone/fax 416-755-4324

ICSID '97 The Humane Village Congress—an examination of how design can contribute to strategies for achieving a more effective economy and humane society in a compassionate and self-renewing setting. August 23–27, 1997, Toronto, Canada For more information contact: Design Exchange, PO Box 18, T-D Center, Toronto, ON, M4K 1B2, 416-216-2124 or 416-216-2161, Fax 416-368-0684.

September 21–23, 1997 Canada's Energy Competitiveness; business, finance, and technology. Niagara-on-the-Lake, Ontario. Contact: Energy Council of Canada, 613-952-6469, fax 613-952-6470

CUBA

Join Global Exchange for the Second Annual Renewable Energy Delegation to Cuba, September 21–29, 1997. Hosted by Cubasolar, Cuba's largest scientific association devoted to renewable energy. Meet with Cuban alternative energy practitioners who are pioneering Cuba's conversion to solar, wind, hydro, biomass conversion and other alternative methods of generating energy. Explore the role of renewable energy in meeting rural and urban energy needs in Cuba; solar energy in agriculture and agro-industry; bioclimatic architecture; ecotourism; cultual and energy consciousness; integration of renewable energy in to educational curriculum at the high school and university levels; research technologies and production of equipment for the utilization of renewable energy sources. Develop long term relationships with Cuba's alternative energy researchers and to help Cuba move toward energy self-sufficiency. For more information contact, The Reality Tour Program, Global Exchange, 2017 Mission St #303, San Francisco, CA 94110, 415-255-7296 or 800-497-1994, fax 415-255-7498, e-mail: gx-info@globalexchange.org, web site: www.globalexchange.org

INDONESIA

The Asia-Pacific Initiative for Renewable Energy and Energy Efficiency Event '97, October 14–16, Jakarta Convention Center. The largest collection of RE and energy efficiency companies in Asia. Includes top speakers and focus on marketing strategies, project financing, policies and incentives for implementation in the Asia-Pacific region. For info: Alternative Development Asia Limited, 5/F 3 Wood Rd, Wanchai, Hong Kong • +852 2574 9133 • Fax: +852 2574 1997 • E-Mail: altdev@hk.super.net • Web: www.hk.super.net/~altdev/

KOREA

August 24–30, 1997, Solar Means Business, Solar World Congress of the International Solar Energy Society, Taedok Science Town, Taejon, Korea. Contact Congress Secretariat, 82-2-3476-7700-11, Fax 82-2-3476-8800-02

MEXICO

XXI Semana Nacional de Energia Solar, September 29-October 3, 1997, Chihuahua, Chih. Mexico. For information contact Dr. Claudio Estrada Gasca, phone (73) 25-00-44 Fax 25-00-18, E-mail: ceg@mazatl.cie.unam.mx

MONACO

3rd Monte-Carlo International Rendezvous of Electric Vehicles, October 16–19, 1997. The Event is composed of a salon, a forum, a conference and prestigious rallye. It offers a veritable panorama of the current electric vehicle market. For more information contact: EPI SAM - 11, Bd Albert 1er - MC 98000 Monaco, tel +377 93 30 00 88 - Fax +377 93 16 03 75

UNITED KINGDOM

Weekend Workshops! Build a wind generator, PV, water heating system or any alternative technology project. Work with others of varying ability in a well equipped workshop. By Robert Keyes GW4IED, of Keystone Systems. Held in Newport close to the M4 J25, Saturday 12–6, Sunday 9–4 with hotel & B/B close by, hard standing suitable for caravans available on site. Through 1997. Contact:Tel/fax 01633 280958.

NATIONAL

Solar Energy & Systems, a college credit course by Mojave Community College. Covers fundamentals of RE for the individual home owner or small villages. Taught on the Internet using the latest technology. Includes weekly assignments for students to review various text books, videos, WWW pages, a weekly chat room, and email questions and answers from students. Tuition $100 plus $10 registration. Contact Don Timpson, 800-678-3992

Online Energy Info Resources—Information on energy efficiency or renewable energy technologies. US Department of Energy (DOE) has two sources of online access. The Energy Efficiency and Renewable Energy Clearinghouse (EREC) BBS Online Service offers users free access to text files, share and freeware programs and utilities, and a free publication ordering system. The service is accessible via the Web at erecbbs.nciinc.com or by modem at 800-273-2955. The Energy Efficiency and Renewable Energy Network (EREN) is also accessible on the Web at www.eren.doe.gov and provides links to hundreds of government and private internet sites. EREN also offers an "Ask an Energy Expert" online form that allows users to E-Mail their questions directly to specialists at EREC. For more information: 800-363-3732.

American Hydrogen Association, national headquarters, 216 South Clark Dr. #103, Tempe, AZ 85281 • 602-921-0433 • Fax: 602-967-6601 • E-Mail: aha@getnet.com • "Prosperity Without Pollution" Web site: www.getnet.com/charity/aha

Energy Efficiency and Renewable Energy Clearinghouse (EREC) offers free info: Saving Energy with Earth Sheltered Living! Today's earth sheltered houses offer both earth friendly and people friendly living spaces. The new Earth-Sheltered Houses (FS120), gives you information on building an earth sheltered home. Also available; Photovoltaics: Basic Design Principles and Components (FS231) provides information on using a PV system for lighting, pumping water, and household appliances; Cooling Your Home Naturally (FS186); Automatic and Programmable Thermostats (FS215). To obtain a copy of FS120, FS231, FS186, and/or FS215 contact EREC: 800-363-3732 • PO Box 3048, Merrifield, VA 22116 • E-Mail: energyinfo@delphi.com • TDD: 800-273-2957 • BBS at 800-273-2955 • Web: www.eren.doe.gov

Visit American Wind Energy Association home page on the World Wide Web: www.igc.apc.org/awea. Visitors to AWEA's home page can obtain information about the US wind energy industry, AWEA membership, small turbine use, and much more.

Last year's American Solar Energy Society & USDOE's & Interstate Renewable Energy Council National Tour of Solar Homes was a great success. To participate in the 1997 event (October 18) contact: American Solar Energy Society, 2400 Central Ave #G-1, Boulder, CO 80301 • phone 303-443-3130 • Web: www.ases.org/solar/

The Federal Trade Commission is offering free pamphlets on: Buying An Energy-Smart Appliance, the EnergyGuide to Major Home Appliances, and the EnergyGuide to Home Heating and Cooling. Copies are available free by writing to: EnergyGuide, The Federal Trade Commission, room 130 6th St and Pennsylvania Ave NW, Washington, DC 20580 or call 202-326—2222, or 202-9326-2502 (TTY for the hearing impaired). The full text of these and more than 160 other consumer and business publication are available through the FTC ConsumerLine: http://www.ftc.gov

SOUTHEAST US

The Self-reliance Institute of Northeast Alabama is seeking others in the southeast interested in Alternative Energy, earth sheltered construction and other self-reliant topics. Interested parties may contact SINA, Route 2 Box 185A1, Centre AL 35960 or E-mail to cevans@peop.tdsnet.com.

ARIZONA

The State of Arizona is offering a tax credit for installation of all types of solar energy systems. A solar technician certified by the AZ Department of Commerce must be on each job site. For info contact ARI SEIA, 602-258-3422.

CALIFORNIA

Siemens Solar Industries offers two levels of PV training: Basic PV Technology Self-Study Course (continuously available), and the Comprehensive Photovoltaic System Design Seminar (final 1997 program: September 22-26). Siemens Solar has been conducting technical and business training continuously since 1982, with an international reputation for professionalism and excellence. The primary instructor, Mark Mrohs, Manager of Training for Siemens Solar (and formerly ARCO Solar), has taught in 25 countries and currently leads the 3-year World Bank funded technical training program being conducted in India. The Self Study program includes our 500-page Training Manual and 9 hours of video lessons and applications, with exercises and examples throughout. The System Design Seminar is a 5-day intensive mixture of lecture, hands-on assembly, labs, and team system design problem solving. Completion of the Self Study program ($500 plus shipping and tax) is a prerequisite for the System Design Seminar ($1000). Read more at our web site and download an application, or contact: Siemens Solar Training Department, Tel: 805-388-6568, Fax: 805-388-6395, email: cvernon@solarpv.com, www: www.solarpv.com

Rising Sun Energy Center presents ongoing Solar Energy Classes including electricity, water heating, cooking, and a kids' day. Contact for schedule and info: PO Box 2874, Santa Cruz, CA 95063 • 408-423-8749 • E-Mail: sunrise@cruzio.com • Web: www.cruzio.com/~solar

Offline will have an Introductory Residential PV Design workshop on Oct. 18 for beginners. Costs $35. Enrollment limited. Contact: 209-877-7080 • Email: ofln@aol.com.

Institute for Solar Living offers ongoing workshops on a variety of subjects. Call Real Goods, 800-762-7325.

COLORADO

Solar Energy International (SEI) offers hands-on workshops on the practical use of solar, wind, and water power. The Renewable Energy Education Program (REEP) features one and two week sessions, PV Design & Installation, Advanced PV, Wind Power, Micro-hydro, Solar Cooking, Solar Home Design, Cob & Natural Building, Straw-Bale Construction and Adobe/Rammed Earth. Experienced instructors and industry representatives. Learn in classroom, laboratory and through field work. The workshops are for owner-builders, industry technicians, business owners, career seekers, and international development workers. The workshops may be taken individually or as a comprehensive program. $450 per week. SEI is a non-profit educational organization dedicated to furthering the practical use of RE technology. Contact: SEI, PO Box 715, Carbondale, CO 81623 • 970-963-8855 • Fax 970-963-8866 • E-Mail: sei@solarenergy.org

Visit the new National Wind Technology Center operated by the National Renewable Energy Laboratory, just outside of Golden, CO. The facilities assist wind turbine designers and manufacturers with development and fine-tuning and include computer modeling and test pads. Call in advance, 303-384-6900 • Fax: 303-384-6901.

8th Annual Solar Energy Fair, August 31 & September 1, Labor Day Weekend! Music from the solar stage, alternative and solar home tours, UFOs, vendors, energy discussions, raffle and a fun time! Contact Jason Jepsen, PO Box 9999, Crestone, CO 81131, 719-256-4038 or 4838

Energy Efficient Building Association Inc. (EEBA)Conference November 5–8 and EEBA Exposition November 6–7, 1997 in Denver, Colorado. For more information contact EEBA, 2950 Metro Dr Ste 108, Minneapolis, MN 55425, 612-851-9940, Fax 612-851-9507, e-mail: http://www.eeba.org

Electrathon America Race, Colorado Electrathon Series, 5th Race, August 25th; 6th Race September 22, Call 303-733-5434.

Solar Energy International teaches Environmental Building Technologies including straw bale, adobe and rammed earth techniques. Get your hands-on at our weekend workshops in September 1997. Tuition is $250. Learn about homes that take less from the earth and give more to people. Contact: SEI, PO Box 715, Carbondale, CO 81623 • 970-963-8855 • Fax 970-963-8866 • E-Mail: sei@solarenergy.org

FLORIDA

14th International Electric Vehicle Symposium, December 15–17, Walt Disney World Dolphin, Orlando, FL. Contact: Pan Turner, EVS-14 Symposium Manager, c/o First Option, 15 N Ellsworth Ave Ste 202, San Mateo, CA 94401 • 415-548-0311 • Fax: 415-548-9764 • E-Mail: firstopt@aol.com

The Sixth Annual SunDay Challenge, September 26–29, 1997. This new breed of auto rally will showcase and promote alternative energy vehicle technology.The rally will start at the Florida Solar Energy Center in Cocoa, FL and finish at Walt Disney World in Orlando. For more information contact: SunDay Challenge Race Committee, Florida Solar Energy Center, 1679 Clearlake Rd, Cocoa, FL 32922-5703, 407-638-1458, Fax 407-638-1010, web site: http://www.fsec.ucf.edu

IOWA

IRENEW is presenting the SIXTH Annual Renewable Energy Expo and Alternate Fuel Vehicle Showcase on August 23 & 24, 1997 at the Johnson County 4H Fairgrounds, Iowa City, Iowa. This is a new time and place but the same friendship, hospitality, and unlimited sharing of knowledge from past years. The Expo will highlight every kind of renewable energy and energy efficiency, there will be more workshops, demonstrations, booths and displays than ever before. There will activities and workshops for kids and teachers, too including an Electrathon workshop and race. For more information contact: IRENEW, Dennis Pottratz, Expo chair, PO Box 2132, Iowa City, Iowa, 52244. Telephone 319-382-3242 or E-mail <gosolar@oneota.com>

I-RENEWs PV Workshop. September 7–8 at the Indian Creek Nature Center near Cedar Rapids, Iowa. Participants will be actively involved in the installation of 24 photovoltaic panels, as well as theoretical learning. For more information contact: Tom Snyder at 319-875-8772 or E-mail: tsnyder@mwci.net

IRENEW and Trace Engineering are presenting a 2 day workshop on PV-Grid intertie systems at the Indian Creek Nature Center, Cedar Rapids, Iowa on September 6 & 7, 1997. This 1000 Watt system is the first grid- intertie workshop in the midwest with material furnished by IRENEW, Solarex, Square D, and Trace. Tuition is $50 for the two day workshop. IRENEW, PO Box 2132, Iowa City, Iowa, 52244. Telephone 319-875-8772 or E-mail bsnyder@mwci.net for information on the workshop.

MASSACHUSETTS
National Green (the leading political party advocate for sustainable power generation) Gathering, August 27 thru September 1, Lawrence Massachusetts. Panels, workshops, labor festival, activism, G/GPUSA Congress. Grace Lee Boggs, Guy Chichester, Ed Bruno, dozens more. $125-150, or daily passes available. LGI, PO Box 43, Lawrence, MA 01842, 508-688-3569, E-mail: lgi@igc.apc.org

NESEA is converting its headquarters into a showcase of environmentally responsive building. Members are converting a historic railroad hub into a working demonstration of a healthy, daylit, office building flanked by a park which celebrates transportation history while demonstrating principles of urban ecology. Opportunities for involvement: Saturdays at NESEA: A volunteer program through which construction novices learn green building tricks of the trades working with professionals. Major transformations of the building and park will be undertaken as “barn-raisings.” Contact. NESEA, 50 Miles St, Greenfield, MA 01301 • 413-774-6051 • Fax: 413-774-6053.

Fall 1997 NSC/QBC’s “Sustainable Series” of Workshops and Lectures: Photovoltaics Design and Installation; Financing Better Buildings; Model Energy Code (MEC) & Weatherization Workshops; & Home Depot Product Seminars, to name a few.October 18, ASES National Tour of Solar Home.November 18–20 Four Workshops at “build Boston”, Passive Solar Design (101); Straw Bale Construction; Energy-efficient Residential Lighting and Daylighting; and Buildings That Work Over Time. If you are interested in any of these Events/Workshops contact: NESEA, 50 Miles St, Greenfield, MA 01301-93212 • 413-774-6051 • Fax: 413-774-6053

MISSOURI
The Missouri Renewable Energy Association is a non-profit educational organization, promoting energy sensible technologies as a solution to global environmental pollution. Improved energy efficiency. water conservation, recycling, and composting are just a few of the topics on our agenda. We encourage local government, businesses, schools, and individuals to become involved by joining the MO.REA today. Contact Ray Wathswski, PO Box 104582, Jefferson City, MO 65110 • 573-634-5051

MONTANA
Life Skills Workshops offered by Sage Mt. Center. Workshops include Making Log Furniture Aug 16, Solar Electricity Sept. 13, Earth Friendly Home Building Aug. 2. All in-depth and hands-on. $45. Contact: Christopher Borton or Linda Welsh, Sage Mt. Center, 79 Sage Mountain Trail, Whitehall, MT 59759 • 406-491-0954

NEW MEXICO
New Mexico Solar Energy Association’s 25th Annual Life Technics Conference & 11th Peter VanDresser Workshop, October 3-5, Ghost Ranch Conference Center, Abiqui, NM. A solar & sustainable village conference. $45 for non-members, late fee after Aug. 22. Contact: NMSEA, PO Box 8507, Santa Fe, NM 87504 • 505-776-2012 • E-Mail: ksolar@laplaza.org

NEW YORK
The New York State Electric Auto Association (NYSEAA) is dedicated to sharing current electric vehicle technology. Monthly meetings. For date and location call Joan, 716-889-9516.

Earth’s Pulse: an Intercontinental Convergence. Caring for the planet and her children by sharing knowledge. Aug 18-24, Brushwood Folk Center, Sherman, NY. Demonstrations, workshops, discussion groups, guest speakers, music, earth ceremonies, and more. A benefit for Eco-Educational Youth Camp. Contact: Don Mackenzie, 4700-A8 Babcock St. NE Drawer 197, Palm Bay, FL 32905 • 800-759-8888 ext. 3211104 (national pager) • E-Mail: EPIC1997@aol.com.

Rally to Stop the Cassini Launch, Saturday, September 20, 1997, noon to 8 PM at the United Nations. Cassini will be carrying the deadliest substance known 72.3 pounds of plutonium. Info: 718-426-5361, E-mail: www.lovearth.org

NORTH CAROLINA
Announcing a hands-on Photovoltaic Design and Installation workshop. Bought to you by Solar Energy International—experts in renewable energy education. This six day event will take place in Ashville, NC. Topics include: solar site analysis, system sizing, PV modules, controllers, batteries, inverters and appliances, demonstrations, lab exercises and hands-on installation. All for a tuition fee of $500. Everyone welcome to join us from October 13 to 18. Contact: SEI, PO Box 715, Carbondale, CO 81623 • 970-963-8855 • Fax 970-963-8866 • E-Mail: sei@solarenergy.org

OHIO
The Great Lakes Electric Auto Association’s mission is to contribute to the freeing of the US automobile market from dependency on petroleum through advancements in electric and hybrid/electric technology. For more info: Larry Dussault, GLEAA, 568 Braxton Pl. E, Westerville, OH 43081-3019 • 800-GLEAA-44 • 614-899-6263 • Fax: 614-899-1717 • E-Mail: DUSSAULT@delphi.com

Solar and wind classes at rural solar and wind powered home with utility back-up. Maximum 12 students. Advance register. $45.00, $50 per couple, lunch provided. Class #1: technical info, system design, system sizing, and NEC compliance, etc. Students will see equipment in use. Every 2nd Saturday of each month.Contact: Solar Creations, 2189 SR 511 S, Perrysville, OH 44864-9537 • 419-368-4252.

OREGON
NATURAL BUILDING WORKSHOP near Corvallis, at the site of Oregon’s first code-approved load-bearing strawbale dwelling. Code-approved techniques and materials applied, with emphasis also on natural and salvaged materials. Work will proceed on an outbuilding on the site, emphasizing straw-bale, and including demonstration of other natural building techniques. August 14-17, $250 to $300. For info call Ned at 541-757-2801, llew@proaxis.com

APROVECHO RESEARCH CENTER is a non-profit educational institute on forty acres nestled in the forest of Oregon. Internship programs March 1, June 1 and September 1. Also, a six week winter internship in Baja, Mexico which focuses on studying and researching appropriate technology applications, learning Spanish, teaching in a grade school, and working in fruit orchards and gardens. Contact: Internship Coordinator, Aprovecho Research Center, 80574 Hazelton Rd., Cottage Grove, OR 97424 • 541-942-8198.

The Lane Community College Energy Management Program is offering a PV design course for the Spring term. Content includes PV electricity basics, modules, batteries, controllers, inverters, lighting, appliances, and installation guidelines. Includes a tour of PV installations and culminates in a design project, David Parker, Instructor. Contact: Roger Ebbage, LCC, 541-747-4501 ext. 2451 • out of area 800-769-9687 • E-Mail: ebbager@lanecc.edu • Web: lanecc.edu:1080/webpages/lcc/science/home.htm

Electrathon America Race, Kilowatt Klassic Eugene Celebration September 20–21 Call Mark 541-345-8376; E-mail: markEmurph@aol.com

TENNESSEE
7th Annual Harvest Festival, Healing Fair and Art Show, August 29–31. Benefits the Kids to the Country Program which gives disadvantaged urban children the opportunity to experience the peace and healing of the natural world. For more information contact Plenty, 51 The Farm, Summertown, TN 38483, phone 615-964-4391, E-mail: plenty1@usit.net

TEXAS
SEASUN, El Paso Solar Energy Association has a new web site: http://www.epsea.org

Photovoltaic Design and Installation! SEI is offering a hands-on workshop in Austin, TX from November 10–15. Tuition cost is $500 for all six days. Topics include: solar site analysis, system sizing, PV modules, controllers, batteries, inverters and appliances, demonstrations, lab exercises and hands-on installation. No prior experience necessary. Everyone is welcome and we especially encourage women participants. Contact: SEI, PO Box 715, Carbondale, CO 81623 • 970-963-8855 • Fax 970-963-8866 • E-Mail: sei@solarenergy.org

September 13–17 1997, The 17th Congress of The World Energy Council, Houston, TX. Contact: Houston World Energy Congress, Inc., 202-331-0415, Fax 202-331-0418

VERMONT
Free PV Workshops for beginners wanting to see working systems and for experienced off-grid people looking to share information and to see new, or different ways of solving problems. Hosted by David Palumbo of Independent Power & Light, first Saturday of most months. Interest will determine which of the following topics will be discussed and demonstrated (as practical): site selection, PV modules, batteries, safety, charge controllers, inverters, DC lighting, balance of system components, system monitoring and maintenance, water topics, snow topics, ponds, living in cold climates, living with our woods, heating with wood, and root cellars. This is a freebie so bring your own lunch and coffee. Contact: David Palumbo, RR1 Box 3054, Hyde Park, VT 05655 • Voice or Fax 802-888-7194, e-mail: indeppower@aol.com

PV Home Electric Systems Seminar and Workshop by Sunnyside Solar. Advanced programs geared toward contractors, carpenters, electricians, plumbers, and architects Sept. 20-21. Cost $190. Program includes lunch, a packet of information, slide show, etc. For info and reservations contact: Carol Levin, RD4 Box 808, Brattleboro, VT 05301 • 802-257-1482 • Fax: 802-254-4670 • E-Mail: sunnysde@sover.net

WASHINGTON
GreenFire Institute is offering workshops and information on strawbale construction. For more information contact: GreenFire, 1509 Queen Anne Ave #606, Seattle, WA 98109, 206-284-7470, fax 206-284-2816, Web site: www.balewolf.com; E-mail: wilbur@balewolf.com

Solar Energy International teaches the Photovoltaic how-to in a hands-on way! Announcing a six day Design and Installation workshop in Seattle for a total cost of $500. Topics include: solar site analysis, system sizing, PV modules, controllers, batteries, inverters and appliances, demonstrations, lab exercises and hands-on installation. No prior experience necessary. Everyone is welcome. We especially encourage women participants. Contact: SEI, PO Box 715, Carbondale, CO 81623 • 970-963-8855 • Fax 970-963-8866 • E-Mail: sei@solarenergy.org

WISCONSIN
The Midwest Renewable Energy Association Workshop Schedule. Call MREA for cost, locations, instructors and further workshop descriptions. Membership and participation in the MREA are open and welcome to all. Significant others may attend with you for 1/2 price. Contact: MREA, PO Box 249, Amherst, WI 54406 • 715-824-5166 • Fax: 715-824-5399

the Wizard speaks…

Video Review

Last issue I reviewed a book on "free energy". This time I will discuss a video that could almost be considered a companion to that book, though produced by different folks. The title of this video is *Free Energy: The Race To Zero Point.* It is 110 minutes long and full of interesting discussions and demonstrations. Many authors, scientists, engineers, and inventors participated in this video.

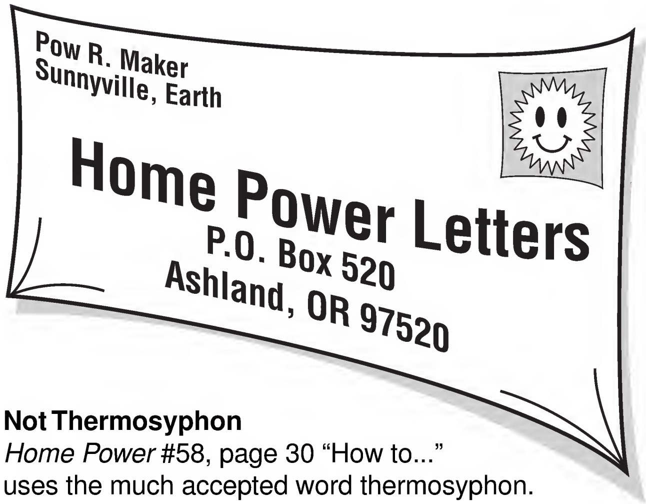
The subject matter includes a wide range of topics from historical to present day and beyond. Theories are mentioned and devices discussed or demonstrated. The fields of endeavor include electromagnetics, electrostatics, permanent magnets, plasma discharges, and nuclear fusion. Heat engines and alternative fuels are also discussed and demonstrated.

Applications for these devices and theories are also covered These include energy generation, propulsion, transmutation, levitation, and anti-gravity. This video is really an introduction to what may be the technology of the twenty-first century and beyond.

The video can be obtained from Lightworks Audio and Video. The address is PO Box 661593, Los Angeles CA 90066-4507. You can order this video by phone at 1-800-795-TAPE. The price is $34.95 plus $5.00 shipping.

E-mail: lightworks@lightworksav.com

Web: http://www.lightworksav.com



Not Thermosyphon
Home Power #58, page 30 "How to..." uses the much accepted word thermosyphon.

As a Ph.D. Physicist (ret.) I have always criticized the use of THERMOSYPHON since the circulation is not related to syphon action. It is from density gradient from thermal differences, a pure weight displacement circulation. But people know what one is taking about using ThSy so I give in.

Florida people have used solar heating of water for years. In the twenties many houses had large solar collectors using black iron pipe! (I've lived in Florida 71 years having been brought here in 1925.)

My own solar I made in 1975 using 7/16" copper tubing (an odd size)—25 feet looped back and forth bending about 165°–170° to obtain a positive slope with no air pocket collector about 3 1/2' x 4' feeding into a 20 gallon tank 2/3 the way to the top (an important point to me) and all heavily insulated. An inside wall switch was used for electrical heating if too many days without sun! Worked fine.Yours for hot water from sun,R. W. Long, Moore Haven, Florida

I can understand your frustration, Dr. Long. I was educated in Physics also and it drives me up the wall when folks confuse power with energy and other Physics esoterica. Bottom line for me is: does it work and can we do it for ourselves? When it comes to cost effective RE (and how long are we going to have justify RE based solely on cost?) the best bang for the buck is solar hot water. It's easy, cheap, and works everywhere. We need to be doing more of it. Richard Perez

Solar 2
Please, please use high quality graphics in your upcoming CD Rom, Solar 2. Low quality graphics make CD Roms very dull even if they do have a lot of information. Who cares if it runs a little slower? At least we can enjoy it!

I guess what I an trying to say is that if I wanted to learn how to read I would pick up a book with some captivating pictures instead of a dictionary!

PS. You have the greatest magazine and I like how your articles stay in one piece rather than having parts all over the magazine! I hate newspapers! Long live the Mac, Alex Gomartely, Willow , Alaska

Hello, Alex. We started selling Solar 2 at this year's Midwest Renewable Energy Fair. It was an instant hit! The photographs are in high resolution (280 dpi) and only very slightly compressed (JPEG low). We've tried printing stuff from Solar 2 and it looks very good on a hi-res color printer. Also prints fine on B/W printers, particularly laser printers. Solar 2 is on sale now, check out the ad in this issue. Richard Perez

Out of Mischief
First off I really enjoy the articles and the advertising in *Home Power* and so do some other people. On page 91 of issue #57 (OOPS that was my last issue, time to renew) you have a special rate for libraries. Here's a subscription for the Arivaca Public Library. Now I can tell those who wish to borrow (and forget to return) my copy of Home Power—Go To The Library. Perhaps this will help keep me from forgetting to renew on time.

Ah, now what's been keeping me out of mischief the past couple of months? What else but resurrecting a 12 Volt, 200 Watt 1940 Wincharger. Building the mast for it to set on was a slight modification of one in an article of Home Power. (Didn't have any long wood poles, but I did have some 3 inch, sch. 40 pipe.) The site it sets on is solid rock, which required drilling five, three inch diameter holes five feet deep, plus four more holes of the same size and depth for the guy wires. Thank God for pneumatic rock drills! The finished height of the mast is 30 feet up from the ground to genny. Yes, it hinges in the middle so that I can work on the generator when necessary. After a storm that exceeded 55 mph winds it was necessary to put the brushes back in their holders. Gonna have to design a folding tail as the air brake just don't work that good at those wind speeds.

Do you happen to have anything on a folding tail for a Wincharger or know who might have such a device? Preferably sketches or plans so that I can build one. I checked with Lake MIchigan Wind & Sun to see if they did and they don't. Got that info (name & phone number) from their ad in Home Power. Would appreciate any help that you can offer on the folding tail, as I hate reinventing the wheel.

The second project is building a rain water collection system. Hmm, one square foot, a tenth of an inch deep is eight ounces of water, now when you have 600 square feet of roof area that is worth trying to save here in the desert. The average rainfall here in Arivaca for the last three years that I have measured is 11 inches per year. That translates to 4,113 gallons per year. At

least it saves on my well water for building my next project, which is a 40' x 50' x 14' high workshop with rammed earth walls. Yeah, been hanging around permaculture people. A very practical people. A very practical concept (permaculture and it works.)

Once again, Thank You for a great magazine and keep up the good work. Carl Martin, Arivaca, Arizona

Sounds like a great tower, Carl. We're lucky around here, most wind tower foundations can be dug with a backhoe or a shovel. I can't imagine having to actually drill the holes, but I'll bet the tower stays put when it's done! We have no specific plans for a folding tail for the Wincharger. How about it HP Readers? We've been getting many letters lately asking for plans to build and modify wind generators. Does anyone out there have such an item and are you willing to share the info in these pages? Richard Perez

In Spite Of

Home Power is a great magazine and I have learned much from your articles. It's exciting to see the alternative energy business grow in spite of the government and industry saying it doesn't work and isn't cost effective. If people paid the true cost of petroleum instead of having huge subsidies, alternative energies would indeed prove cost effective. Either way, I feel that by using solar, being as energy efficient as possible, and especially sharing and educating friends and anyone who will listen, the future seems a little brighter because those of us who have taken the plunge to use alternate energies and be pioneers in a field that has far to go. Keep up the good work HP! Linda S. Ochs, Waterloo, New York

Thanks for the flowers, Linda, but with all the work you are doing, the flowers should be placed at your feet.

I remember the first few issues of Home Power; ten years ago we had fewer than twenty ads per issue. Now the number of advertisers in each issue is greater than a hundred. The RE business is growing rapidly in spite of minimal government and big business support. Home power is a grass-roots movement toward an affordable and sustainable energy future. Since renewable energy sources are freely offered to everyone daily, it is of little wonder that big business is not interested. There is no future in renting out sunshine. I look on this as an added benefit to RE. We can raise our own energy just like we can raise our own food in a garden. Self sufficiency has benefits far beyond just no electric bill to pay. Richard Perez

An Incredible Inn

Please send a gift subscription to John and Joan Dobson, builders and proprietors of Dobson House Inn, El Prado, NM (505-776-5738).

The Dobsons, at an age when the majority of folks are retired, almost single handedly constructed a 6000 square foot inn based on renewable energy systems. The architecture is based on an Earthship design with many customizations. These are some truly remarkable folks. I think they would be good candidates for a Home Power profile article but I fear there modesty might prevent it.

When my family and I stayed at Dobson House earlier this year John and I had a long discussion about battery maintenance. John Wiles' article on batteries would be of interest to the Dobsons.

At the bed and breakfast was a model of an EV that John Dobson helped design and build when he was a professor of engineering in Texas. We only scratched the surface of the Dobson story and came away with the feeling that this remarkable couple is unique. They are the Renaissance couple.

By the way, we've been solely on solar electricity for about seven months. For two years leading up to our change of lifestyle I avidly read *Home Power* magazine and it gave us the confidence to take the plunge. Thanks for the information you provide. Larry Swisher, Penrose, Colorado

Hey, Larry, maybe we can get an HP reader to profile the Dobsons. They sound like folks who have already traveled paths which many of us are just starting. Publishing technical information about small scale RE is our main mission at Home Power. Most of our articles are written by our readers. Sharing is where it's at! Richard Perez

Flawless Performance

Great going HP folks. We just returned from a six month cruise on our 36 foot Ketch in Mexico. Our RE system performed flawlessly. It included photovoltaics, batteries, inverter/charger and associated controls. Great sailing, serene anchorages and uninterrupted, silent power! Eric and Nicole, Rainbow Voyager

Hello Eric and Nicole! I'm green with envy, six months of smooth sailing and RE to boot. You are indeed lucky folks. Sailboats are excellent platforms for solar and wind power. I'd like to run more articles about RE on sailboats, that way when I'm ready to run away to sea, I'll know what works. Richard Perez

Ballon Lighting

I have been subscribing to *Home Power* for the last couple of years and have managed to collect most of the back issues. I consider your magazine as a treasure and hope you will continue the excellent work for years to come.

Recently, I happened to see a programme on BBC (Tomorrow World) of an invention in France where a helium filled balloon with a CFL fixed inside the balloon, could light up a large area and this invention has been successfully used in many road accidents in remote areas. This invention opens up several possibilities in energy savings. I have failed to get more information from BBC. Can you throw some light on this? Dr K.S. Dhathathreyan, H 129/1, 34 Cross Road, Besant Nagar, MADRAS 600 090 INDIA; e-mail: Partha@giasmd01.vsnl.net

I've never heard of this idea before, but I don't see why it wouldn't work. Perhaps one of our readers in the UK can supply you with access data for this invention. Richard Perez

Consumption

In HP #59, I found the chart of the Evans electrical energy consumption (RE Earthship Design) very useful. Obviously, everyones electrical energy consumption is idiosyncratic. Our house, like the Evans house, has a washing machine (a Whirlpool, not a Staber at least not yet) and a gas dryer (a Kenmore). I immediately noticed that the Evans use their washing machine for 3 hours a week, and their dryer for 1 hour a week. This is commendable. It means that they are not drying most of their clothes in the dryer. They must be using a clothesline.

If a family takes the wash out of the washer and throws it into the dryer after every load of wash, they will find that, on the average, they will be running their dryer for twice as long as their washer, not one-third as long.

By the way, our washer draws 780 to 960 watts, considerably less than the Evans washer (1450 watts), while our dryer draws a little more (312 watts, versus the Evans 250 watts). If the Evans were using their dryer for every load, and if their dryer drew 312 watts like ours does, they would find that their dryers daily average of total electrical consumption would jump from 1.9% to 12.5%.

I certainly agree with the basic message conveyed by your chart: in most alternative homes, the washing machine and the refrigerator consume the bulk of the energy. The chart helps confirm my plan to buy a Staber as soon as I can afford one. Martin Holladay, P.O. Box 72, Sheffield, Vermont 05866; e-mail: holladay@kingcon.com

You are correct Martin, the largest electrical energy consumers in a well designed home RE system are the refrigerator/freezer and the washing machine. Bob-O and Kathleen's tests of the Staber washer show it using an average of 251 watt-hours per load of wash (see HP47). Karen and I just bought a Staber and should have it installed before long, so we'll let you know how it works here on Agate Flat. We are planning on using a clothes line outside in the summer, and in the greenhouse in the winter.

Using simple strategies can reduce the washers burden on a small RE system. Just as the Evans learned, the time to do the wash is midday, not at night. This allows the washer to consume less battery-stored energy, and allows the battery to recover after the wash. If you are using solar to heat the water, then daytime clothes washing makes more effective use of the sun's energy, and saves propane. Richard Perez

Steam Power

In your response to a letter from a reader in Issue # 58, you invited information about steam power.

I have worked for over 20 years on systems which generate electricity using point focus solar collectors. What began as complex equipment primarily suitable for industrial applications is slowly evolving into quite simple, practical, robust technologies, appropriate for homeowners.

Because I live in the cold and cloudy Northeast, I burn wood for heat in the winter. I am building a wood-burning 5 kilowatt electric reciprocating steam engine driven power plant which will allow me to generate power in addition to providing heat and domestic hot water. Once the system has worked well for a year, I will add a fixed-focus solar concentrator to fire the unit when the sun shines and reduce the need for wood and removing ashes.

Although they've been around for a long time, small steam engines have been essentially neglected for a century. Typical, old fashioned steam engines used low pressure saturated steam (up to 200 PSI and 450°F). They usually turned pretty slowly (less than 400 RPM), were very heavy (3 horsepower engine with boiler together weighed a ton or more), operated for a long time (decades) and could be easily maintained by backyard mechanics. They were not very efficient, converting less than 5% (often less than 2%) of an energy resource into shaft power.

Over the years I've used a variety of steam engines and have the most experience with piston operated valve engines. In this type of engine the piston opens a ball or poppet valve which admits a small amount of steam. Depending on the design, the steam expands 10 to 20 times as it drives the piston down until it uncovers exhaust ports. These single-acting unaflow engines can be moderately efficient (to 16% steam to electricity) but require that the steam exhausts into a vacuum. Any internal combustion engine can be easily converted into a steam engine using this technique. We used 3 and 4

cylinder Lister Diesel engines to reliably produce 32 to 48 kilowatts (60 kW peak) at 1,850 RPM (3 phase AC induction generator) using steam generated in the receiver of a large point-focus solar collector or by burning oil. Although these systems worked well, they needed significant maintenance every few months and had complications we can now avoid.

Probably the best prototype small steam engines were designed and tested by the Doble brothers in the 1920's for use in steam powered vehicles. These high performance (converting up to 25% of the available heat into usable power) engines: are still state of the art, can operate at higher speed (to 2,000 RPM), are lighter (100 HP version less than 500 lb. including the boiler and auxiliaries), and use higher pressure superheated steam (1,600 psi at 900° F). They were very simple to operate, were maintained by backyard mechanics and lasted a long time (still ran well after 500,000 miles). A variety of fuels were burned to generate steam for these engines including wood chips, brown coal, coke and oil.

I am working with a small version of a Doble engine which was designed in New Zealand and probably built in England (I found it in Canada). This compound (exhaust steam from the high-pressure piston expands further in the low pressure piston), double-acting (the pistons deliver power both on up and down strokes) engine produces up to 20 horsepower at 2,000 RPM and weighs 65 pounds. The monotube boiler fits into a bushel basket, and has coils of small tubing (1/2 OD and less) totaling 250 feet. This type of boiler is quite safe because there is very little water (3 pints) at high pressure while it is operating. In its current configuration, the engine requires steam produced by burning about 4 pounds of wood to generate a kilowatt-hour of electricity. By the coming heating season I hope to integrate these components with the chunk wood furnace I use to heat my home. The furnace will burn a 140 pound load of wood in about 5 hours which should generate 20 kilowatt-hours (stored in a bank of batteries) and deliver 500,000 BTUs of heat (condensing the steam after it exits the engine) into the hot water storage tank.

Since I have to work full time at an unrelated job, in my free time I can only develop components which make economic sense for my family of four. The furnace took only a few weeks to assemble out of firebrick, insulation, metal parts, a fan and simple controls. My six cords of wood for next year are already under cover so over the summer I'll be rewinding a conventional 230 volt at 850 RPM, 7.5 HP DC motor (as 28 VDC 760 RPM 5 kW generator) for this project. A far better solution would be an Al Forbes type generator matched to a simple, low cost triple or quadruple expansion Doble-type engine which should improve performance above 25%, steam to electricity. On the input side, an automatically fed wood chip/pellet furnace backing up a solar boiler is ideal for me. If others show interest in this type of approach I will try to coordinate my work with theirs.

How much should one of these simple, high performance 5 kilowatt steam systems cost? The answer depends on who puts it together and who is responsible for keeping it running. Parts or raw materials should cost roughly $500 each for an engine, boiler, generator and safety/control components. The situation is similar to the early hobby computers where nerds had to assemble systems using available chips, storage devices, and interface/display components. Only after customers define substantial markets do well integrated systems evolve. If all goes well, I hope to be able to write a *Home Power* system article with pictures and lots of graphs/diagrams by the summer of 1998. Bill Rogers, DEng., 99 Mickel Hill Road, Troy, NY 12180; email: MickelHill@aol.com

You're on, Bill, we will be looking forward to your steam article. Skip Goebel of Sensible Steam (417-336-2869, E-mail: 104247.127@compuserve.com) also responded to our request for steam info with a blockbuster article, look for this in an upcoming issue. Richard Perez

Managed Forests

I will be building my electricity independent home from trees I sawed from my land, glad to see your concern for dead trees, however, forest's managed right can be sustainable. I planted eleven acres of my agricultural land back to trees, hope it helps your concern. I like your advertising design philosophy, great mag—only had one slightly damaged cover—coming in great shape. I am also interested in home sized steam/electric plants—wood fired. Dick Linderding, Elmond, WI

See the letter above, Dick. We're working on some steam stuff. I agree—wood is a sustainable resource. We burn about four cords of firewood yearly here at Funky Mountain Institute. I'd love to get some electrical energy as well as heat. Richard Perez

New York Professional

I am a solar professional installing solar thermal and solar electric systems in New York state. We have been doing renewable energy installations since 1978. Check out our web site: http://ourworld.compuserve.com/homepages/DaveNRGman/savnqnrq.htm

I am really impressed with *Home Power* mag. It is the

best I have ever seen and it is superior to even the solar trade magazines in terms of pictures, diagrams and practical nuts and bolts usage. Dave Austin, South New Berlin, New York

Thanks for the flowers, Dave. We try our best to make HP as good as we possibly can. Our main purpose is the communication of technical information. Our attitude is, "If we can do it (and none of us are rocket scientists), so can you!" Richard Perez

A Very Small PV Tipi

We live in a solar powered tipi at 9300 feet. It is amazingly satisfying and the system is so small. 44 Watts of panel, 81 amp hours-full battery, small controls. It powers lots of light, radio, CD, CB, AA battery recharger for headlamps, chainsaw sharpener, & recharger for 9.6 Volt Makita cordless tools, etc. Lots of Sun! Robert Janssen, Aspen, Colorado

Hey Robert, You have probably noticed by now that we ran the tipi picture you sent us in #59, page 4. I would like to encourage you to send us an article on your tipi system. We receive many requests for small system articles. It would net you another two year sub! Karen Perez

Start to Finish

Please, Please, Please continue to run your articles start to finish. It has always been a pet peeve of mine to have to continually flip through a magazine hunting for the rest of the article.

Also, I believe that adults should be able to check and renew subscriptions on their own. It is a measure of ones appreciation of whatever one is subscribing to.

Good information! Keep up the good work. Judy Criswell, Chiloquin, Oregon

Most of our readers feel as you do, Judy. We will continue to run articles without breaks or ads. Our advertisers are very cooperative and realize that HP subscribers read everything in the magazine, including their ads. After all, knowing how to use the technology is useless if you can't get your hands on the hardware. Richard Perez

Cassini Mission Plutonium

The Cassini mission to Saturn is the #1 censored story on Earth, LOVEARTH® is organizing the national effort in trying to stop the October 6, 1997 launching by NASA of Cassini. There are three major rallies scheduled. The United Nations on Saturday 9/20/97, noon to 8 PM; the White House on Sunday 9/28/97, noon to 8 PM; and Cape Canaveral Air Station on Saturday 10/4/97 starting at 2 PM.

I am writing to you asking for your help to make these rallies as successful as possible. With your support and involvement at any one of these rallies the goal of stopping Cassini will be that much greater.

At 5:38 AM/EDT on Monday, October 6, 1997, from launch complex #40 at the Cape Canaveral Air Station, a spacecraft called Cassini is supposed to lift off. On board Cassini will be 72.3 pounds of the deadliest substance known, Plutonium (Pu). Inhaling less than 27 millionths of a gram of Pu will give you lung cancer, NASAs own odds state there is a 1 in 345 probability for a release of Pu on this mission. There are 2.3 million people within the six county region surrounding Cape Canaveral. If there is a failure on lift off like the 1/28/86 Challenger did at T+73 seconds and the Pu is released, the prevailing winds in October are blowing back over all these people. Worst case contamination clean up costs for this region run at 4.1 trillion, it could be useless for 12,000 generations.

Cassini is to use the 72.3 pounds of Pu not as a fuel to propel it, but to power (by the heat given off during radioactive decay) three Lockheed-Martin built radioisotope thermal generators that will create the modest 745 watts of electricity, to run all of the on board instruments and experiments. This modest generation of 745 watts of electricity, can now be done in deep space conditions, by using a combination of advanced photovoltaics (solar power) and long lived fuel cells. (European Space Agency 4/29/94)—the safe way.

Cassini is a 3.4 billion dollar, eleven year mission that is to explore Saturn and one of its satellites, Titan. After a hopefully successful launch, to get out to Saturn (the on board rockets don't have the thrust), Cassini must use a maneuver called the gravity assist swingby. This maneuver is accomplished by flying very close to a planet and using that planets gravitational field to transfer some of its energy to the spacecraft to increase its velocity tremendously. This will be used four times, on 8.16.99 will swingby Earth at an altitude of only 310 miles, traveling at 711.666 miles per minute, leaving only a 19.81 second window of trajectory. If something goes wrong and Cassini inadvertently reenters our atmosphere the extreme temperatures of 3000 degrees plus will vaporize Cassini and the 72.3 pounds of Pu will be released, possibly causing tens of millions of premature deaths, mostly from cancers over the next couple of decades.

Please take a few minutes to visit the web site www.lovearth.org to find out how to help stop this launch. Mark Elsis, Lovearth, 84-10 53rd Ave, Elmhurst, New York 11373; 718-426-5361

Plutonium is indeed nasty stuff. It strikes me that shooting it into space is a dumb idea for all the reasons you have mentioned. But then I'm not a rocket scientist. Richard Perez

Misaddressed
This letter is in reference to the article in *Home Power* #58, titled "Empirical Investigations of Solar Water Heating Technology" by Dennis Scanlin. This article was well written and informative. I am new to the concept of solar heating and would like to utilize such a system to heat a 24' round, above ground swimming pool. At the end of Mr. Scanlin's article there is a list of sources for additional information, one of which is the Florida Solar Energy Center. I have written them and called the number given and neither the address or phone number listed go to this business.

Could you please advise me on any plans or other information which I can study before attempting to build a swimming pool solar heater. Some persons have advised me to simply use 1/2" or 3/4" black PVC on my roof and then tie it into the pool filter pump.

I would appreciate any assistance which you may be able to give me. Dennis Pellegrino, Canton, Ohio

Sorry about the mistake, Dennis. Here is the correct access data: Florida Solar Energy Center, 1679 Clearlake Road, Cocoa, FL 32922-5703 • tel: 407-638-1458 • FAX: 407-638-1010 • www.fsec.ucf.edu

If I wanted to do some hands-on solar thermal, I'd call Smitty or Chuck at AAA Solar (800-245-0311 • www.rt66.com/aaasolar). These fellows are "Da Solar Guys" and stock all the bits and pieces you will need. They also have a wealth of design info. Richard Perez

EV Help Needed
I am starting an experimental project. With it I wish to prove or disprove some ideas that I have on expanding the range of a battery powered vehicle. What I need: and hopefully you can steer me toward: is information. To be specific I am converting a 1973 VW Beetle into an "electric powered trike." I know that hobbyists have converted VWs, as well as other makes of automobiles, into EVs (electric vehicles). What I don't know is where so I go for engines, kits, controllers, supplies, experience, etc. on how to convert a Volkswagen transaxle into adopting an an electric power plant. Please help me.

At this point in time I can only be reached by phone "answering machine" or by mail. If your organization can help me, it would be greatly appreciated. If you can help me but there is some cost involved, this is still not a problem. I can forward the cost "preferred method", or I can handle C.O.D., if I know ahead of time, what it and the cost is.

Your help will be greatly appreciated. Marshall Lund, W 4824 Woodlund Rd, Preshtigo, WI 54157, 715-789-2256

When it comes to putting electric motors on VW transaxles, the folks at Electro Automotive had done more than anyone I know. Give Shari or Mike a call at 408-429-1989. Richard Perez

Please, Oh Please
Flog me with the blades of a wind generator! Lash me to the mount of a PV tracker! Cement my toe in the hole of a leaking hydro dam! I have let my subscription Expire!!! I am guilty of premeditated slackness. I read my label last month & knew it was the next to last issue for me and thought "Oh I have plenty of time to send in my renewal money!" Then I received my Last Issue and thought" Oh, I must send in my money in the next few weeks." Now as I look in the mail box each day for the next Magazine—Alas—I am struck by the reality that it is not coming!!!

PLEASE, OH PLEASE, OH PLEASE take this check & cash it as soon as you can to help pay for more paper, ink, computer disks, & all the other things it takes to produce your wonderful magazine. Hopefully my slackness will only cause me to miss one issue. (I wonder how long I can check out that issue from the library at our University?)

In all seriousness—Thank you to ALL the people who help put *Home Power* together. I am considering giving a one year subscription to my customers who buy a complete system from us. What better way for a new system owner to learn about what is "out there" and how it works & what other like minded people have learned from their experiences. Enclosed is copy of my mailing label. I am anxiously waiting to receive my next issue as I recover from my flogging. Rod Baird, Rock Castle Solar, RR 2 Box 677, Boone, NC 28607 • 704-264-4484

Don't worry, Rod, we won't let you miss an issue! Richard Perez

Re: Tom Snyders Letter #59
The solar water heating system described in my article (issue #58) is designed for the "do-it-yourselfer" to build simply, with available materials that can be purchased cheaply at a local hardware store. With this design, the water is heated mainly by radiation and convection and very little is heated by conduction. The copper piping grid inside the collector is not soldered to the galvanized steel roofing panel. It is only touching it in a few places where it is attached and both surfaces are painted with a high quality, high temperature paint. With proper painting corrosion between dissimilar metals does not happen. In fact, if the galvanized steel roofing panel is left out of the system, the system would still heat water and work very well! The corrugated galvanized steel roofing panel (absorber) is only there

to absorb some radiant heat and re-radiate that heat to the colder water within the pipes. The gist of my article is keep it simple and cheap.

If I wanted to sell the readers on a copper-plated thermal collector, I would have just suggested that they purchase one from American Energy Technologies, because for the money, they build a very fine product, but that wasn't the point of the article at all.

The #1 reason why less than 1% of American households use solar water heating is because the systems are too expensive, are loaded with unnecessary gadgets, and they have a bad reputation for needing expensive repairs. Conversely, in Australia, over 10% of the households use solar water heating. Over there, the systems sell for less than $1500 installed and they use direct and glycol based thermosyphon systems, and that is why people buy them, they are cost effective.

In my article, I was showing the readers how they could have solar water heating for about $500. Thank you, Perry A. Bocci. Gainesville, Florida

It is very easy to get provincial with solar DHW. What is KISS in climates like Florida's, can be a frozen disaster in Iowa. I agree with you, many solar DHW systems are needlessly complex, but those of us living in cold climates need to protect the system against freeze-ups, and still produce hot water in the winter. Once again, when it comes to renewable energy, one design does not fit all situations. Happy systems are custom designed for the application and environment. Richard Perez

120 Volt Power

Home Power magazine and the *Home Power* staff provide a valuable connection to RE users, news and technical information. I think you are doing an excellent job.

It seems petty for me to request more articles about 120 volt Dc and ac systems but that is all I need to make your publication perfect for me. I use 120 VDC power because, back in '84, when we were starting here, a 120 Volt Jacobs was available and we have a long run from the machine to the house. Keep up the good work. Paul Kenyon, Bridport, Vermont

High voltage DC systems are becoming more common as system sizes grow. Years ago 24 VDC was considered high, now over 160 VDC is considered high. Most of the high voltage DC system pioneers were running the old Jacobs wind electric gear. Now we are seeing PV/utility intertie systems running voltage between 48 and 160 VDC. How about it HP readers? A report on one of your high voltage DC systems? Richard Perez

Blackouts

Coming home to a secure electricity supply is almost impossible to describe to those who take electricity for granted. Living in a country where blackouts are once again averaging well over 12 hours per day, where a burning main power line cut us off for five days last week and a gravel truck took down our line for a three week outage in January, we think that the investment in solar power has much more than paid for itself. As I write this, we are once again the only house in sight with electric lights on, although I can hear a noisy generator somewhere off in the distance. One of the nice things about solar is that you can build the system in an incremental fashion, as finances and/or needs (read: sometimes desperation) allow. Keep up the good work with the reports, ideas and evaluations. I read (and reread) it all. D J Farquharson, Haiti

As you have discovered, DJ, having a power supply that is reliable is just one of the benefits of RE. Many of our international readers live in areas where the utility grid is less than reliable. I remember our trip to Colombia in 1992. Colombia is about 80% hydro-powered and was in the middle of a drought. There were rolling blackouts everywhere, and the grid was present less than half the time. In downtown Cali, we saw hundreds of gas generators, running on the sidewalks, powering the city's businesses. Many of the more upscale homes had battery/inverter combos. While not solar-powered, they could store grid energy when it occurred and use the stored energy during blackout periods. Add a few PV modules to this system and the power becomes constant and reliable. In the over twenty years during which we have made our own power here at Agate Flat, the only time it has stopped has been when we are working on the system. I'd match the constancy of an RE system to the grid anywhere, any time. Richard Perez

Living Well

We live well on 1 KWH per day. We have refrigeration, a water pump, adequate lights, radio, TV, washer, and during periods with excess power, we run all of our power tools building the latest addition to our house.

Our local dealer, David Palumbo has been a real help. *Home Power* has been our bible, our source of inspiration and knowledge. Keep it up! Sam Russell, Craftsbury Common, Vermont

One KWH a day is a lot of energy, if it is used well. You have evidently learned to use your energy in the most efficient fashion. You are doing better than we do here at Funky Mountain Institute. We cycle about 10 KWH per day (about 70% for Home Power magazine production and the rest for our home). David Palumbo is one of the original RE pioneers—he knows how to

really squeeze all the energy out of a KWH! Richard Perez

At Twice the Price

I would pay for your Journal at twice the price. It has helped me over and over, and I'm a master electrician. I have two trackers and one rack mount. Also, a 1500 watt wind generator on a 50 foot pole. All together about 5 KW. Our best energy day has been 29,000 watt-hours.

Before I installed all of this my light bill averaged over $150.00 per month. Our last bill for March was about $25.00. Our average year round electric bill is now around $50.00 per month. G A Feris, Tolar, Texas

Wisconsin Brownouts

I believe the $29 million Wisconsin Energy (WE) sunk into its recently abandoned merger with NSP is partially responsible for an increased risk of summer power shortages in Wisconsin.

As a conservation and renewable energy advocate, I can't begin to estimate how much legal time or airline tickets this money bought. But, I can estimate what $29M would have bought in energy conservation or renewable energy capacity. Both technologies would've reduced the current risk of any summer power shortages.

If WE had sunk $29M into utility scale wind turbines over the past 22 months, it would now own fifty, 600KW wind turbines capable of producing 30 megawatts peak (@ 12% of one Point Beach Nuclear reactor) or enough juice to power a city the size of Cedarburg, about 10,000 residents.

Had WE invested its merger funds into energy conservation measures like electric motor replacement etc. the economic and environmental returns would have been even greater.

Energy conservation measures would DOUBLE the above savings. So, $29M invested in energy conservation would save about as much energy needed to power a city of 20,000, Like Watertown.

Finally, the environmental opportunity costs WE failed to gain from this money will affect people beyond Wisconsin because air pollution from coal power plants has no boundaries.

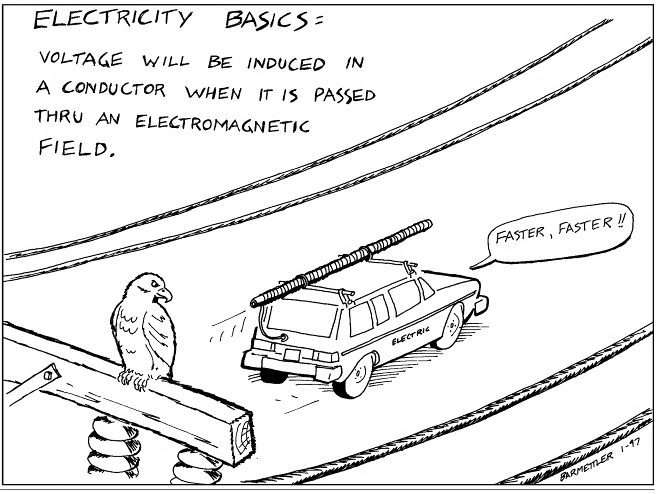
Twenty-nine million dollars invested in clean, quiet wind turbines would have saved 67,500 barrels of oil or 16,875 tons (about 175 train car loads) of coal each year. The carbon dioxide emitted from this coal would require 1,650,000 trees to absorb it during each year of the turbines 30 year design life. Again, the above savings are doubled for energy conservation measures.

Regrettably, WEs cookie jar is now $29M lighter. This money could have certainly eased the risk of energy shortages and made a large down payment on a clean, safe and more secure energy future for all WE customers in Wisconsin and beyond.

Customers must now prepare for a summer of possible brownouts and increased air pollution. Those outcomes would have been greatly reduced had the merger funds been invested wisely in energy conservation and utility scale wind turbines. Mike Mangan, Delafield, Wisconsin

It's going to take America's utilities a long time to realize the benefits of RE, Mike. On a good day, I figure that we are dealing with huge businesses with tremendous interia—this is the way they've always made power and they see no reason to change. On a bad day, I figure that utilities are basically greedy and see no profit in renewable energy. I've worked with Wisconsin utilities and found them to be among the most reasonable and enlightened in the nation. Try talking RE utility intertie with a mega-IOU like Pacific Gas & Electric and you'll see what I mean.

Until America's utilities realize that their hundred year monopoly on electric power is over, can we really expect them to change? During the next century, the utilities role will be one of distribution and storage. The power source will be the big nuke located 93 million miles from this small, green planet. Power conversion will happen everywhere—every roof top, and every hill. Each of us will be power producers and the utilities will broker this energy where it is needed. This change will happen slowly, like all meaningful changes. The best way to hurry it along is to put our homes on RE and sell our excess to the local utility. This is the way the world changes, one system at a time.… Richard Perez



Writing for **Home Power** Magazine

Home Power is a user's technical journal. We specialize in hands-on, practical information about small scale, renewable energy systems. We try to present technical material in an easy to understand and easy to use format. Here are some guidelines for getting your RE experiences printed in *Home Power*.

Informational Content
Please include all the details! Be specific! We are more interested in ispecific information than in general information. Write from your direct experience—*Home Power* is hands-on! Articles must be detailed enough so that our readers can actually use the information.

Article Style and Length
Home Power articles can be between 350 and 5,000 words. Length depends what you have to say. Say it in as few words as possible. We prefer simple declarative sentences. Sentences which are short (less than fifteen words) and to the point. We like the generous use of Sub-Headings to organize the information. We highly recommend writing from within an outline. Check out articles printed in *Home Power*. After you've studied a few, you will get the feeling of our style. System articles must contain a schematic showing all wiring, a load table, and a cost table. Please send a double spaced, typewritten copy if possible. If not, please print.

Editing
We reserve the right to edit all articles for accuracy, length, and basic English. We will try to do the minimum editing possible. You can help by keeping your sentences short and simple. We get over three times more articles submitted than we can print. The most useful, specific, and organized get published first.

Photographs
We can work from any photographic color or B/W, print, slide, or negative. We prefer 4 inch by 6 inch color prints which have no fingerprints or scratches. Do not write on the back of your photographs. Please provide a caption for each photo.

Line Art
We can work from your camera-ready art. We can scan your art into our computers, or redraw it via computer. We usually redraw art from the author's rough sketches. If you wish to submit, via computer file, a schematic or other line art, please call us via telephone.

Got a Computer?
We use Macintosh computers to make *Home Power*. We would like your article's text on 3.5 inch computer floppy diskette. This not only saves time, but also reduces typos. Please also send a hardcopy printout of your article in case the electronic copy doesn't work. Please format all word processor files in "TEXT" format. We can also read text files on 3.5 inch IBM disks (800 KB, or 1.4 MB). Please format the IBM word processor files as ASCII TEXT.

You can send your article via modem to either the HPBBS at 707-822-8640 or via Internet as an enclosed TEXT file(s). HPBBS address is: Richard Perez

Internet email address is:
richard.perez@homepower.org

It is wise to call, via voice, ahead of electronic file submission. This is particularly true concerning graphics files. There are many, many ducks and they all need to be in a row....

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Ozonal Notes

Richard Perez

On the road—
the 1997 Midwest Renewable Energy Fair

Well we actually did it. We rented a 30 foot long motor home and drove the HP Crew some 4,600 miles to the MREF and back. Crew members Karen Perez, Ben Root, Michael Welch, Don Kulha, Joe Schwartz, and myself made the trip and amazingly enough everyone is still on speaking terms.

The concept was to travel on the surface instead of flying. We had too many close calls on commercial airlines lately. No one wanted to fly again. We figured out the cost would be about the same (and it was), and thought we'd use the extra time spent on the road to work on this issue. Well, it didn't turn out quite as we expected. Here's what happened.

All of us piled into Ben's Monster Van (a huge, '79 Dodge, custom 4WD beast) and drove to Portland, Oregon to pick up the RV. After getting lost in Portland, we finally managed to get all of our stuff stowed in the RV and got Ben's van parked in the long-term lot at the Portland airport. We were on the road and stayed that way for the next 46 hours—all the way to Amherst, Wisconsin.

Working on the road turned out to be a fantasy. Even though we'd brought along three computers, the RV bucked and pitched far too much to type. Besides the crew was captivated by America rolling by, working seemed a waste of this unique opportunity. We took four or five hour shifts driving, and everyone stood a watch. Don was the only one among us with extensive RV experience. He has crossed America a dozen times in an RV while working with NASA. The rest of us were RV novices and quite frankly, piloting the *Boat-hemoth* (as we named this RV) down the road scared the hell out of us. But we quickly adapted to life in motion and had no real close calls. I know that many HP readers have RVs and many are "full-timers." I was looking forward to learning how life on the road was conducted and what you folks deal with on a daily basis. I was not disappointed by this crash course.

Since this is only the second RV I have ever made a long trip in, I have little to compare it with. In my humble opinion, however, this RV was an expensive pile of barely functioning junk. It was a '96 Chevy "Flyer" with the coach portion done by "Fleetwood". The Chevy portion worked OK and it didn't strand us on the road. It got a respectable 8.6 miles per gallon (which according to Don ain't bad). The coach stuff on the other hand barely functioned. It took us 24 hours to finally figure out that the refrigerator wasn't working on 12 VDC and move it over to propane (thereby voiding our insurance in the event of an accident). The black water waste tank gauge indicated a full tank when in fact it was nearly empty (this caused us to drive miles out of our way to find a waste dump we didn't need). The bathroom sink drain leaked all over the floor. The interior stowage doors and drawers wouldn't stay shut and sprang open as we traveled. The major door lock on the cabin didn't function, and the outside stowage cabinets also would not lock. And finally the 4 kW. generator on board had a fuel problem and barely ran. I've heard from others (my parents went "full-timer" RV after my Dad's retirement) that RVs are only slightly less complex than the Space Shuttle and contain many more parts than either a home or a truck. I can believe it! I know why they call it "full-timer". It's a full time job keeping all this stuff working! I can now appreciate the space constrains present in these RVs. Having to try to run the 4 kW genny to grind coffee (a 130 watt job) makes me realize why so many of our readers with RVs are going PV/inverter/battery systems. Enuf griping, we chose the ship and now we had to sail it.

An essential ingredient in any road trip with Home Power is coffee, or the lack of it. This crew can get really ugly if decaffeinated. One of the big attractions for RVing to the MREF was the ability to make good coffee on the road. By good coffee, I mean the high torque, black goo with stratospheric caffeine levels. Karen brought along our coffee works and Don supplied five pounds of special dark roast coffee. While we had to stop to make it, this coffee got us down the road. We tried making coffee in motion with predicable results (and no mop on board). If you on load coffee, then you must off load coffee—the outhouse in motion saved us many pit stops.

We drove the northern route along I94. I have driven this route (same time yearly to MREF) on several occasions, but have never seen Montana and North Dakota so wonderfully green. Unfortunately, this route has constant high winds and keeping the RV on the road was much more difficult than we expected. I will never cuss out an RVer who is weaving in the wind again. Hey, if you can keep it on the road at all, then you are doing great!

After nosing the *Boat-hemoth* into several places where we had to back it out, we realized why Don kept saying, "Truck Stop, Truck Stop!" Since maneuvering this boat was dicey in city traffic, we stuck to the truck stops by the interstate. We had to stop about every five hours for fuel and to slop and water the crew. While one of us drove, another navigated and fetched coffee for the driver. The rest of us either watched America go by, or tried to sleep. Only half us could successfully sleep in the back bed. It pitched and rolled wildly when the RV

was in motion. The motion in an RV is far different from the regular motion of a small boat. It is irregular and difficult to either walk or sleep in.

Michael Welch gets the "White Knuckles" award for his piloting of the *Boat-hemoth* in a windy, heavy, driving rain, in the dark, and down the steepest grades along I94 eastbound out of the Rockies. I spent an anxious hour back seat driving him, and then went to bed, deciding that I would rather die in my sleep. After 46 hours of motion madness, we arrived—MREF '97!

For a photo report of this years MREF see page 24 of this issue. We had a great time, met with old friends, and made new ones. This fair was well worth the hours of travel to get there and back. It is the best and largest energy event in the nation, and we wouldn't miss it. While at the fair, the *Boat-hemoth* showed us why people RV. We had our home right there on the fair grounds. It was wonderful to be able to visit with other RE crews after the fair closed for the day. The *Boat-hemoth* served as a Home Power home away from home. Michael Welch stashed a keg of his homebrew beer in the RV's shower which everyone enjoyed. We had a cell phone in the RV and were able to keep in touch with Agate Flat and all happs. After going to bed way late, we could sleep until the fair opened (no get ready and travel to get there). We had a wonderful time and will be back next year.

Like all good things, MREF finally ended and we were faced with the trip back to Oregon. We loaded up the RV like seasoned veterans, everything in its place and tied down. We left Amherst at 8 AM on the morning of June 23 ; it was full speed ahead.

Any road trip involves eating out—and let me tell you, this crew considers themselves food critics. While I've seen this crew chow down on anything available, they know good grits. The best french fries of the journey were made by Mary Lou's cafe in Neillsville, Wisconsin. Even Mr. Xtra Crispy (Michael Welch) agreed they were the epitome of the french fry. On the food front, things turned ugly around Fargo, North Dakota. Karen mutinied, claiming she'd ingested enough greasy truck stop food to lubricate a Buick! I decided we had better find her favorite food, sushi, quickly or else. Well, there is no sushi in Fargo, so it was truck stop food again. The rest of the trip can be best described as the "Search for Sushi." We finally, after two aborted attempts, located Karen's favorite in Spokane, Washington. Special thanks to Joe Schwartz for piloting the *Boat-hemoth* into downtown Spokane in search of sushi. Here we passed a more than mildly pleasant time scarfing raw fish and swilling dark beer. Sufficiently fortified, we we able to make the last stage of the journey back to Portland and the return of the *Boat-hemoth*.

When we returned the *Boat-hemoth*, the RV rental guy walked around the rig twice. He was amazed that there were no new dings and said so. We all smiled and silently thanked fate and Don Kulha's experience for sparing us accidents. We presented the RV guy with a list of a dozen broken items on the RV and were glad we didn't own it and have to fix it. We picked up Ben's Monster Van and headed home to Agate Flat.

While we didn't get much real magazine work done on the road, we did get to be together and share this intense experience. Perhaps this was the best feature of our road trip to MREF. It brought this crew together for a wonderful experience—MREF and getting there and back. We all preferred this mode to flying and staying in motel rooms. We liked it so much that we are thinking of converting a bus for next year's trip. We do a fair number of "road shows", we dislike flying (also it's expensive with a crew of six to eight), and we all like traveling together. During the off season we are planning on using the bus as visiting dignitary housing here on Agate Flat. I know that many of you, our readers, have traveled this road before. Any suggestions as to bus conversion, which bus to start with, and what works? Please give us some help because we sure need it! This bus needs to be able to travel back roads, be dependable, and act as home for a crew of eight.

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Web: www.homepower.com

Written using solar power at the Funky Mountain Institute, Agate Flat, Oregon

42° 01' 02" north 122° 23' 19" west.

Q&A

Good 12 Volt Stereos

Just a quick tip for Edward Brown (Q&A HP#59): I bought a JVC bookshelf system in 1993 that has a 12VDC input in the back. It has a CD player, tape player, receiver, amp, remote control, auto on/off, bass boost, and two pretty good bookshelf speakers. It cost $280 in 1993. We run it all the time and it has been trouble free. Just go down to your local electronics superstore and look for 12VDC inputs in the backs of the (bookshelf) stereo units!

Mitch Hayne, Estes Park, CO • e-mail: Mel_and_mitch@prodigy.com (Gridless in the Rockies)

Another 12 Volt Stereo Idea

In HP59 Edward Brown asked about a 12 Volt home stereo. I agree that car stereos just don't make it. Here's my solution, I'd have shared it sooner, but thought I was the last person on earth to stumble on it.

Most portable stereo's with CD players use eight C or D cells. (8 x 1.5 Volts = 12 Volts) Hmmmm.

My test subject was the cheapest unit I could find at the time with 1 CD and 2 tape decks—all I needed for $90. They have gotten much fancier and cheaper.

As I didn't want to void the warranty by opening the bugger up I built a wooden battery replacement. Sized to fit in the battery compartment loosely, with sheet metal screws to secure the wire and make contact with the the power tabs, and cross drilled to put the cord thru as a strain relief. The battery spring at the other end holds it in place. I nipped a corner off the battery compartment door to let the cord out.

I put this together two years ago and it has worked great. As a bonus, because it was designed to work on batteries, it is very power efficient, drawing only 3/4 amp with both CD and tape running. Thomas J Houseman, Rapid River Michigan

Thanks Mitch and Thomas for sharing your 12 VDC stereo solutions. I'd also like to add a caveat. The 12 VDC power supplies powering both the stereos you mentioned operate at a voltage range that is tighter than a large 12 VDC battery. Be sure to check that you are not feeding the stereo more than 12 VDC (for example, a 12 VDC system battery while under charge can reach voltages in the 14.5 to 15 VDC range). This may be too much voltage for some stereos. You can build a regulator to make sure that the stereo is not overvoltaged. See HP #40, page 104. Richard Perez

Cell Rotation

With regards to the question "Cell Rotation", posed by Edward Brown (Q&A, HP#59), we would like to present our thoughts on the issue of terminal cell failure. Premature terminal cell failure, in our opinion, is often the result of stray currents running across the top of the battery. Dirt and/or moisture on the top of the battery is typically the cause of stray currents, establishing an alternative path for the current, which results in some current by-passing the middle cells and producing a lower on charge voltage for these cells (compared to the terminal cells). The voltage regulator monitors terminal voltage and in order to compensate for low voltage on the center cells the terminal cells are placed in an overcharge condition. This frequent state of charge causes the terminal cell(s) to fail.

The first paragraph in our Preventative Maintenance Instructions is as follows:

One of the most severe abuses that a lead-acid battery will receive is cleanliness, or lack of it. Dirt, corrosion, water and acid will rob a battery of a full life. A clean well kept battery will extend its useful life. Keeping the battery clean and dry will minimize stray currents. Electrolyte on top of the battery does not evaporate and can only be removed by neutralizing.

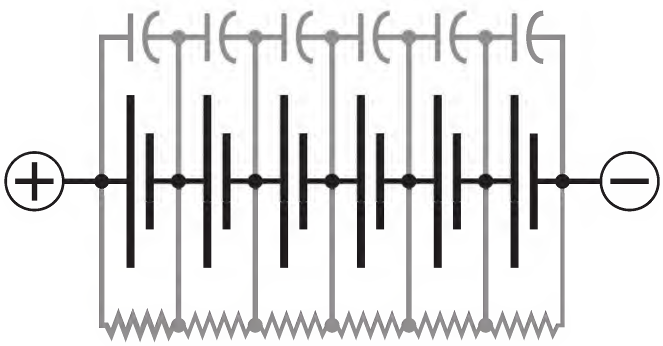
When we designed our Dual Container batteries stray currents were one of our concerns. The removable protective cover insures that the tops of the cells are always clean and dry, thus eliminating the possibility of stray currents. Many smaller batteries are designed with an attempt to prevent this problem by utilizing a solid "one-piece" cover. Unfortunately, the distance between the terminals is relatively short and stray currents are still able to cross the tops of these covers.

I hope our opinions have been, in some way, helpful and look forward to reading the opinions of others.

David Surrette, Surrette Battery Co Ltd, PO Box 2020, Springhill, Nova Scotia, Canada B0M 1X0/Rolls Battery Engineering 800-681-9914

Thanks for the battery feedback, David. Keeping the battery clean is essential to long battery life. I'd like to also add my two cents regarding the outside cell failure problem.

Every battery is really a series set of cells. Each individual cell has resistance and capacitance. I computed the cell capacitance of a large cell (350 A-h) at over seven Farads. Cell resistance is very small—a few hundredths of an Ohm. In fact, a 12 Volt lead-acid battery really looks like the diagram here.



Note that each of the end (terminal) cells is not buffered by a series resistance and capacitance. This means that the end cells endure the full brunt of any electrical activity. While much battery discharge is DC in nature, there are often discharge services which have alternating current characteristics. For example, every inverter is a 60 Hz. binge consumer of battery power as is every DC motor directly powered by the battery. In this "high current/no current" ac service, the outside cells do not receive the filtration of the series resistance/capacitance, hence they receive more severe electrical (and mechanical) service. This idea first occurred to me while watching battery current on an oscilloscope when an inverter was powering a large load. Inverters can demand high surge currents from a battery, and by the very nature of ac electricity, at some points on the waveform, there is no current flowing. This stresses out the outside cells (major positive and negative) in a battery. The only solution I can think of is to routinely rotate the series connected cells which make up the battery, hence spreading out the wear and tear. Richard Perez

Well Question for HP Readers
I have a 440 foot deep well in Malibu, California. It consists of 6" casing with 1/8" slots in the bottom 60 feet which enables the entry of water. Malibu water is notorious for containing dissolved minerals, including troublesome calcium. As water seeps into the casing through the 1/8" slots, calcium deposits accumulate. This clogs the slots and restricts the entry of water. When the well was first completed in 1989, I could pump water continuously at 12 gallons per minute. Water now enters at a rate of 2/3 gallon per minute. Other area well owners respond to the problem by sending down a drill and banging on the sides of the shaft, mechanically removing the calcium build-up. This is followed by blowing out the entire lower portion of the shaft with a compressor. The entire process quickly becomes expensive, into the thousands of dollars. One particular well owner utilizes this method yearly. An interim maintenance method is to drop the well head as low as possible and pour muriatic acid into the well. The acid sits overnight, and breaks down the calcium to some degree. Then the well is throughly flushed and put back into use.

I am currently looking into an epoxy process, to which the applier claims, calcium and other minerals cannot adhere. I should be receiving sample epoxy coated pipes soon and can conduct tests for verification. However, before I become involved any further, I would like to know what success, if any, other readers of HP have had solving these types of problems with their wells. Calcification, lime build-up and hard water problems are so common that there must be a base of information out there from which to proceed. Don Tollefson, Malibu, California

How about it HP Readers? Can anyone help Don beat the calcium in his well? Richard Perez

Q1 EDTA, Q2 Winter PV Angle
I have two questions:

(1) Does it make sense to use EDTA regularly as part of battery maintenance instead of waiting until the batteries are in a sorry state of affairs?

(2) I've been thinking about the tilt angle of my panel mount. As I understand it, it is recommended to adjust the winter tilt to the longest point the sun will reach. I suppose it's somewhat academic, but it seems to me that this does not maximize winter sun since the sun is only at it lowest point for one day. There must be some angle above the lowest point that actually, on average, absorbs more solar radiation. Does this make sense to you?

Thanks in advance for your thoughts. Scott Shipley, Hermon, New York

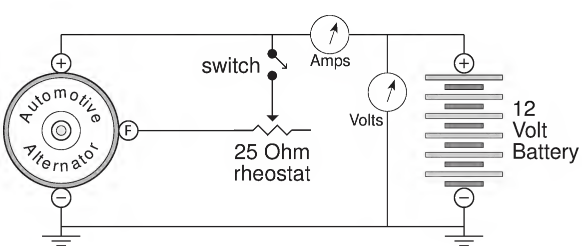
Hello Scott. In the case of question 1, EDTA is usually a last gasp measure for severely sulfated cells. I have no data on adding EDTA to healthy cells in order to prevent sulfation. I suspect that regular equalizing charges will be more effective. Also consider one of the new electronic desulfators (see the Abraham Solar ad in this issue) to keep sulfation at bay. One of the problems with EDTA treatment is that it removes sulfate ions from the cell's normal operating electrochemistry. Equalizing charges and electronic desulfators return the sulfate ions to useful service within the cell.

Answer to question 2: You are right, adjusting the PV modules for maximum energy production is more complex than setting the array perpendicular on mid summer's and mid winter's day. See my article in HP#36, page 14. Adjustment is best done in mid February, mid April, mid August, and mid October. The angle is site specific and depends on your latitude and also on when you next plan on adjusting the array. Richard Perez

Alternators

I need to learn about alternators. Like how does one connect the field, pole, positive and ground up. Does the field go to a regulator and then to the positive? I would like to experiment hooking up an alternator to a bike, and using that to charge/replenish the battery. I have several GM alternators with field and pole connections. Wm Nienajadly, Clifton, New Jersey

The major positive and negative output terminals on an alternator are plainly marked and color coded on most alternators. The positive output terminal goes to the positive pole of the battery and the negative to the negative. If the alternator has two field terminals, then connect one to the battery positive and the other to battery negative. If the alternator has only one field terminal, then connect it to the positive battery terminal (the other field connection is probably grounded inside the alternator). Many modern alternators have a built-in electronic regulator. If you get one of these, open the alternator and disconnect the regulator. Use a rheostat to limit the amount of current fed to the field. Here is a schematic of how it goes together. See HP#42, page 28 for a discussion of car alternators and how to use them in home power systems. Richard Perez



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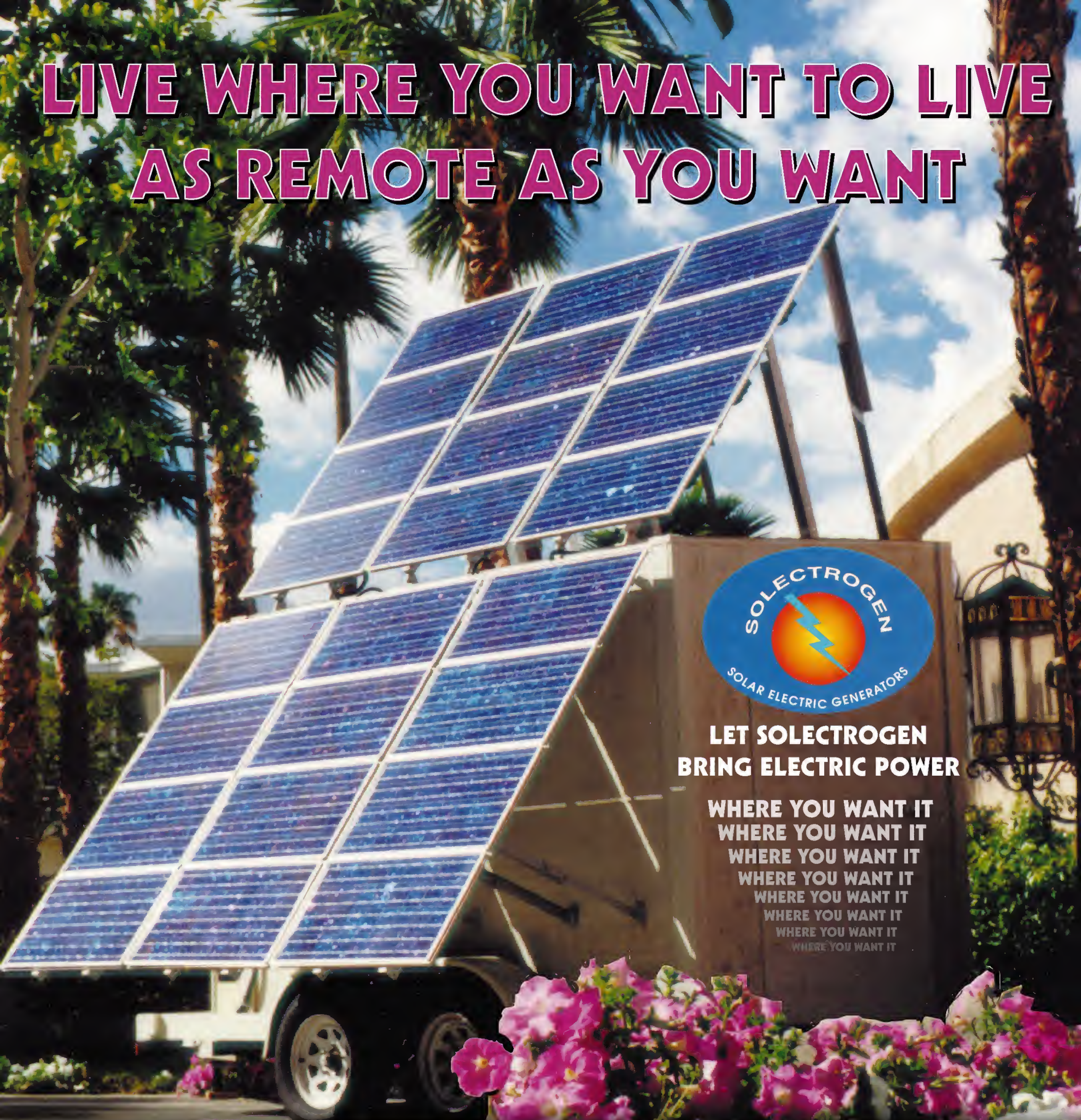
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